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HOLMARC
PHYSICS
INSTRUMENTS
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PHYSICS INSTRUMENTS

- SPECTROSCOPY
- INTERFEROMETRY
- POLARIZATION
- FIBER OPTICS
- LASERS & OPTO-ELECTRONICS
- DIFFRACTION
- OPTICS
- MECHANICS
- ELECTRICITY & MAGNETISM
- ACOUSTICS
- HOLOGRAPHY
- THIN FILM CHARACTERIZATION
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HOLMARC Optomechanics

HOLMARC
PHYSICS
LABORATORY EQUIPMENTS
23 Years of service

Products For
General & Engineering
PHYSICS

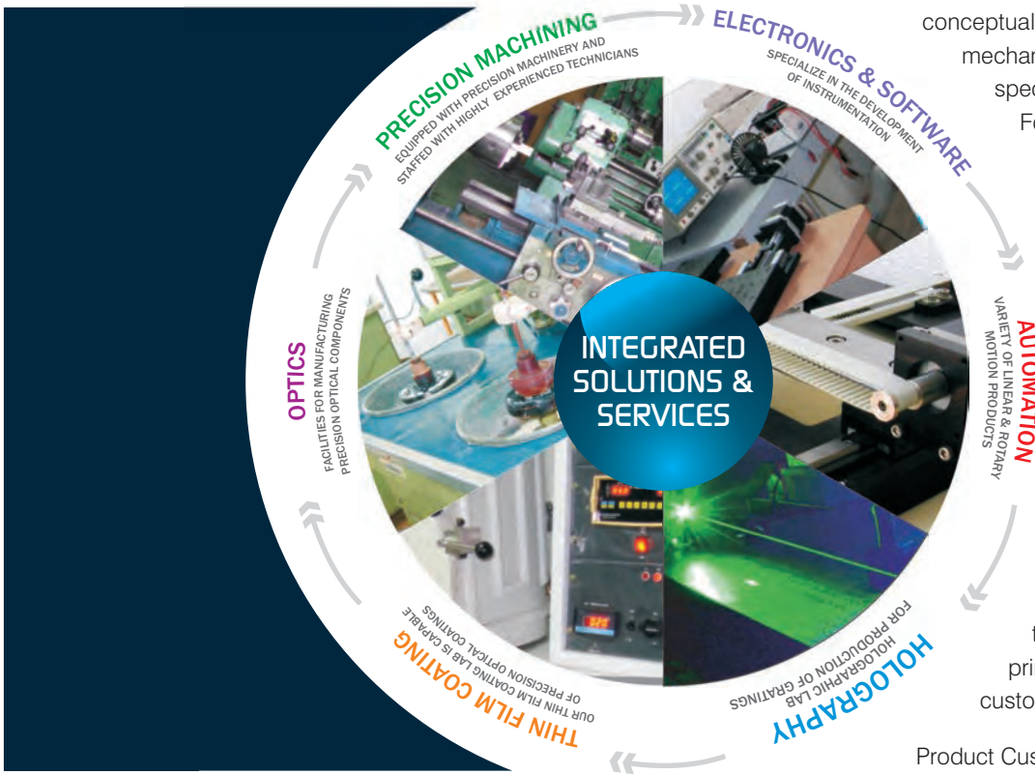
23 YEARS
CELEBRATING EXCELLENCE

All products are manufactured and marketed by Holmarc Opto-Mechatronics Pvt. Ltd

Because of continuous product improvement, the various data listed are subject to change without notice. Please confirm before ordering.

For more products and informations, log on to **www.holmarc.com** or contact us at mail@holmarc.com

Why? HOLMARC ?



Multi-disciplinary capabilities: Over the years, we have built expertise and capabilities in multitudes of engineering and scientific disciplines right from conceptualization to manufacturing. Our capabilities range from mechanics, optics and embedded systems to thin film metrology, spectroscopy and microscopy both in design and manufacturing. For many of our products, in addition to design and development, we carry out manufacturing process development as well. When Holmarc products are ordered, our customers can be sure of receiving products with our combined experience and expertise.

Cost effective solutions: Though we strive to be the best in the world in respective product domain, we maintain lean manufacturing operations to keep our costs as minimum as possible. The savings are passed on to our customers and as a result our products are most cost effective compared to our competitors with comparable performance.

After sales service: We make sure that all our products are in working condition to the satisfaction of our customers throughout its life cycle irrespective of warranty period. It is our principle not to make any of our products obsolete as long as customer would like to use.

Product Customization: Leveraging our multi-disciplinary capabilities, we routinely customize our products for specific applications. Our engineers are more than willing to work with users throughout the product development and manufacturing process.

International sales and Service

All of Holmarc's products described in this brochure are designed and manufactured for world market with state of the art design and contemporary features. Though products are specified in metric units, we manufacture in British units as well. Similarly, our devices which require external power are manufactured for 220 VAC and 110 VAC.

Holmarc has presence throughout the world for all our product verticals. We ship directly to our customers where our exclusive distributers are not present. Where ever commercially viable, our engineers visit customer site for installation and training. When personal visits by our engineers are not economically suggestive, we encourage video conference for technical discussions as well as for training and service. There are routine training sessions conducted regularly for personals from our global distributors at our factory on all our products. Our esteemed customers, where ever they are globally, can remain assured of responsible service and supports from Holmarc either directly or through our channel partners.

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Company Profile

Established in 1993 and located in Kochi, India, Holmarc Opto-Mechatronics P Ltd manufactures variety of scientific and engineering instruments for research, industry and education. Our products in the fields of spectroscopy, microscopy, holography and thin films reflect capabilities we have in multitudes of disciplines, be it optics, mechanics, photonics, electronics or computer science.

Our strength is 175 people as of January, 2016 and is still growing. All our departments, be it optics design, optics manufacturing, mechanics design, electronics R&D or soft-ware development are all manned by experienced professionals in the respective disciplines. We have 25000 sq. ft. built up area for housing our manufacturing infrastructure in optics, mechanics and electronics. With state of the art machines, equipments and instruments, Holmarc technicians and engineers bring out world class products, each distinct and best in its kind. Holmarc is unique in its approach to providing after sales service. We give maintenance and modification support for all our products as long as our customer needs it irrespective of warranty or year of purchase. We do not make any of our products obsolete, rather encourage our users to modify and use as long as it is technically possible.

Product Profile

The products described in this catalogue are the result of years of experience in manufacturing various scientific instruments for research and industrial application. We have made deliberate attempt in the design of these apparatus to keep all components and modules open as far as possible. This approach help students to gain deep understanding and in most cases provide them hands on experience in setting up the experiments.

All components and modules used in our products are of highest quality comparable to the best in the world. The design of experiments are in tune with state of the art trends in the field. Our expertise in the integration of optics, mechanics and electronics are fully made use in all these apparatus and equipments.

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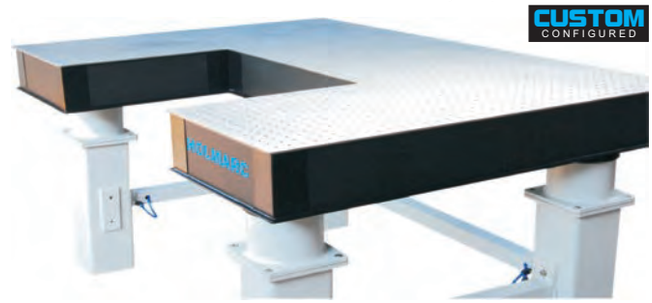
Setting up an optical laboratory begins with Optical tables

OPTICAL BREADBOARDS, TABLES & ACCESSORIES

Capabilities & Customization

HOLMARC breadboards and tables are designed specially for research applications in laboratories and industries. The design stresses functionality and performance at the lowest possible cost. Advanced materials and designs are used to provide increased vibration damping and decreased weights when compared to conventional breadboards and tables.

HOLMARC's experienced support engineers will be glad to help you. Call us at +91 484 2540075 or send us a mail to mail@holmarc.com or sales@holmarc .com. We will do our best to meet your performance level



Optical Laboratory Workstation

HOLMARC Optical Workstation is an ideal solution for automated test, research, microscopy and any application that requires an optical table. Safety officers will love this workstation because it offers laser blocking panels, antireflective surfaces, ergonomic design, and ground fault protected power. Optional fume extraction enhances the safety of cutting operations, toxic gas handling and applications utilizing hazardous chemicals.

Workstations can be totally customized for specific requirements. Enclosures, fume hoods, lighting, shelves, arm rests, power strips are other accessories.

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SPECTROSCOPY

Spectroscopy is the study of interaction between radiation (electromagnetic as well as particle radiation) and matter. Spectrometry is the measurement of these interactions and an instrument that performs such measurements is called a spectrometer or a spectrograph. A plot of the interaction is referred to as a spectrogram or informally, a spectrum.

It is one of the major tools for analysis of trace metallic elements in industrial and environmental laboratories. In a typical spectroscopic analysis, concentration of few parts per million of a trace element in a material can be detected through its spectrum. Our products in this section review both the modern and classical quantitative methods of spectroscopy.

Spectrometer-Goniometer 01
Model No: HO-ED-S-01

CCD Based Constant Deviation Spectrometer 02
Model No: HO-ED-S-0203

Flame Spectrometer 03
Model No: HO-ED-S-03A

Hydrogen Spectra - Balmer Series 04
Model No: HO-ED-S-03B

Zeeman Effect Apparatus 05
Model No: HO-ED-S-04A

Laser Raman Spectrometer (PMT Based) 06
Model No: HO-ED-S-06

Laser Raman Spectrometer (CCD Based) 07
Model No: HO-ED-S-06A

Confocal Laser Raman Spectrometer 08
Model No: HO-ED-S-06B

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PHYSICS

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Spectrometer - Goniometer

Model No: HO-ED-S-01

Spectrometer-Goniometer (Model No. HO-ED-S-01) is a versatile instrument for studying the spectrum of different light sources as well as for characterization of components like prisms and gratings. Unlike common spectrometers, this model is designed in such a way that students get better understanding of the working principles of spectrometer. All modules are deliberately made open and easy to understand. Students gain hands on experience in the basics of spectroscopy.

Experiment Examples:

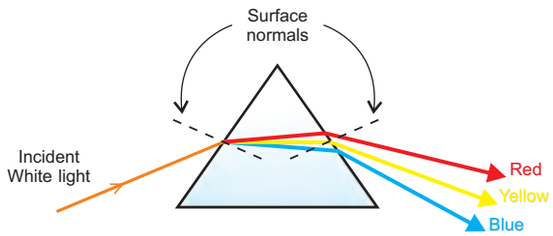
- Determination of refractive index of the solid prism
- Dispersive power of the material of the prism
- Refractive index of various liquids using liquid prism

SPECTROMETER-GONIOMETER - Related Topics

- Dispersion
- Refractive index
- Dispersive power
- Angle of minimum deviation
- Refraction Grating

SPECIFICATION

Telescope magnification	10X
Resolution of prism table	10 arc Minute
Resolution of Goniometer	1 arc Minute
Variable slit	Micrometer controlled continuously variable 0-3mm



This Goniometer is used for measuring optical data of prisms. It offers precise angle and refractive index measurements. The well designed mechanics of the Goniometer allows maintenance-free operation over many years. Conventionally, the measurement of refractive index is carried out with a dispersion prism made from the material to be tested. For the measurement of refractive index of fluids, a hollow prism, which is filled with the fluid is used. It can also be used as a spectroscope for qualitative examination and measurement of emission and absorption spectra.

Features:

- Modern and user friendly design
- Mercury lamp is used as light source
- Symmetrical precision slit
- Height of prism table is adjustable
- High-quality optics
- Comprehensive manual Included

Scope of supply	Quantity
Goniometer(resolution 1 arc min)	1 no.
Optical rail(length 300mm)	1 no.
Slit with mount(slit size 0 - 3mm)	1 no.
Collimating lens with mount(diameter 50mm)	1 no.
Mercury vapour lamp with power supply(input 230V, 50 Hz)	1 no.
Telescope(magnification 10X)	1 no.
Hollow prism(material PMMA)	1 no.
Equilateral prism(material N-SF1)	1 no.
Grating(groove spacing 600 lines / mm)	1 no.

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CCD Based Constant Deviation Spectrometer

(For Arc Emission & Absorption Measurements)

Model No: HO-ED-S-0203

The apparatus uses CCD imaging instead of photographic silver halide films. It has become difficult to carry out silver halide film based spectroscopic experiments in class rooms due to the unavailability of consumables and hurdles in its processing. CCD imaging of the spectrum is a timely solution. Data acquisition is easy and fast. As most of the commercial spectroscopes are based on digital imaging, students get an exposure to the latest trends in spectroscopy

Mercury is used as a standard element in most cases. Knowing the wavelength, corresponding to different spectral lines, elements can be judged. Hartmann's method is employed to determine the unknown wavelength.

PC BASED CONSTANT DEVIATION SPECTROMETER - Related Topics

- Continuous Spectrum
- Emission Spectrum
- Absorption Spectrum
- Hartmann's constant

If a transparent substance is placed between a continuous source and a spectrometer, the substance absorbs a certain part of the spectrum. Hence in the continuous spectrum of the source, a few dark lines or bands appear. This spectrum is called absorption spectrum of the substance. This method is useful for manufacturing as well as for academic experiments. Constant Deviation Spectrometer (Model No: HO-ED-S-0203) can be used for the study of spectral series viz. emission spectra of elements, absorption spectra of compounds, quantitative spectrum analysis etc.

Experiment Examples:

- To measure the wavelength of absorption bands of $KMnO_4$ and calculate it's Hartmann's constant.
- To find wavelength of prominent lines of the emission spectra of copper, iron and brass

Features:

- Modern , user friendly and precision design.
- Emission and absorption spectra can be observed.
- CCD imaging system
- High-quality optics produce sharp and clear spectra.

When a substance is heated, electrons first absorb energy, go to a higher energy level and eventually fall to a lower level, by emitting photons. Every element emits a characteristic spectrum of its own. There are certain important and prominent spectral lines associated with each element. These lines are used to distinguish one element from another. In the experiment to determine an element, spectrum of standard known source is pictured first.

SPECIFICATION

Design	Constant deviation 120F
Prism type	Pellin Broca (N-SF1)
Refractive index	1.7
Wavelength range	380 - 680nm
Resolution	0.1nm
Input	Micrometer controlled slit

CAMERA SPECIFICATION

CCD sensor	line sensor
Number of pixels	3648
Pixel size	800 x 200 micron
ADC resolution	16 Bits
Exposure time range	0.1ms - 6,500ms
Frame rate	Up to 138 scans/second
Interface	USB 2.0
Compatibility	Windows 7 or higher

Scope of supply	Quantity
Constant Deviation Spectrometer	1 no.
Metal Arc Stand (Arc Cavity 0-25mm)	1 no.
Copper, Iron, Brass Rods	10 nos each
Metal Arc power supply(Output 0-100V,0-10A)	1 no.
Mercury Vapour Lamp with power supply	1 no.
Incandescent lamp(Output 25 W)	1 no.
CCD camera	1 no.

Flame Spectrometer

Model No: HO-ED-S-03A

Flame spectrometer is an instrument used for the analysis of emission and absorption characteristics of different materials. Holmarc's Flame spectrometer (Model No: HO-ED-S-03A) is able to analyze the spectrum of samples repeatedly with high speed. As we know, German Physicists Robert Bunsen and Gustav Kirchhoff discovered the spectral emission activity in the 18th century, which is modified here.

We use sodium metal for the experiment, which is placed in crucible and heated with Bunsen burner. Light from sodium flame is coupled to an optical fiber and taken to input port of the spectrometer. The output of the spectrometer produces standard D_1&D_2 lines. In turn, in absorption spectroscopy, partially continuous spectrum of halogen lamp passes through the sodium flame. The cooler atoms in the centre of the flame absorbs certain region of halogen spectrum which produce D_1 and D_2 lines as absorbed dip lines. However, absorption or emission spectra will reveal the spectral characteristics of the material.

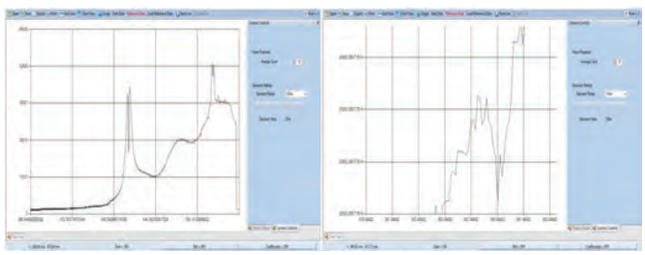
Experiment Examples:

- Calibration of prism spectrometer using Hartmann constants
- Absorption spectrum of sodium D lines
- Emission spectrum of sodium metal /customized materials

Features:

- Both solid & liquid samples can be analyzed.
- Capable of automatic live recording of flame spectrum (customized version)
- Computer –controlled, user-friendly interface.

A safety cage design is used in flame spectrometer as a security system for controlling sodium metal hyper reactions .Cage is made of float glass for safety and visibility. Gas tube attached to Bunsen burner is protected using metal cover. Metallic crucible in fine size allows safe melting of sodium . Safety goggles are provided with the equipment .



★ Emission spectrum of Sodium metal

★ Absorption spectrum of D lines in continuous spectrum

Holmarc's flame spectrometer is calibrated using mercury source which uses Hartmann's constants as calibration method. It can be upgraded for research purpose and can be used to analyze absolute transmittance or reflectance spectroscopy by small modifications. CCD linear array detector is used in prism spectrometer. It will support UV-VIS-Near IR regions.

SPECTROMETER SPECIFICATION

Prism	Pellin Broca(N-SF1)
Spectrometer input	Micrometer controlled slit (fibre coupled custom version)
Spectrometer output	CCD electronic output through USB via computer
Wavelength range	390-1000nm
Wavelength accuracy	+/-0.6nm
Abs/emission accuracy	+/-0.5nm
Calibration source used	Mercury lamp
Absorption light source	Tungsten Halogen lamp (20W)
Calibration type	Based on Hartmann's constants

DETECTER SPECIFICATION

CCD detector	Sensitive linear array 0-3647pixels
Pixel size	800 x 200 micron
A/D resolution	16 Bits
Pixel O/p clock	0.5MHz
Exposure time	0.1 - 6500 ms
Frame rate	138scans/second
External trigger	yes
Compatibility	Windows 7 or above
Interface	USB 2.0

FLAME SPECTROMETER - Related Topics

- Emission spectrum
- Hartmann's constants
- Sodium D lines
- Absorption spectrum
- Prism spectrometer

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Hydrogen Spectra - Balmer Series

(Determination of Rydberg's Constant)

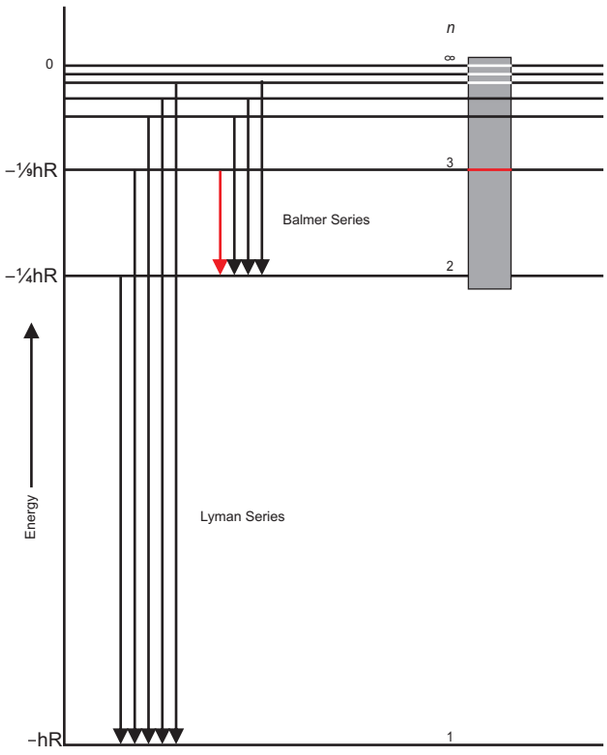
Model No: HO-ED-S-03B

Optical spectra of atoms can be observed both in absorption and emission. When we transfer energy to the atoms of certain gases, they emit a characteristic spectrum consisting of lines. Further more, these atoms can absorb light having the same wavelength as the wavelength of the emitted ones. When an electric current is passed through a glass tube that contains hydrogen gas at low pressure, the tube gives off blue light. The emission spectrum of atomic hydrogen is divided into a number of spectral series, with wavelengths given by the Rydberg's formula. These observed spectral lines are due to electrons making a transition between two energy levels in the atom. The classification of the spectral series by using Rydberg's formula was important in the development of quantum mechanics as well as in astronomy for detecting the presence of hydrogen and calculating red shifts.

When the light from hydrogen discharge tube is passed through a spectrometer , five narrow bands of bright light are observed. Each of these narrow bands have characteristic wavelengths and colors. In this experiment, prism based spectrometer is used to measure the wavelengths of the emission lines of hydrogen. Before the wavelength measurement, the spectrometer is calibrated with mercury discharge tube and Hartmann's constants are calculated and verified. With the wavelength measurements of hydrogen lines, it is possible to compute the Rydberg's constant.

Experiment Examples:

- **Calibration of the prism spectrometer using mercury lines**
- **To calculate and verify Hartmann's constants**
- **To study the emission of light from a hydrogen discharge source**
- **To learn the empirical formulas to characterize the pattern of spectral lines from hydrogen**



The permitted energy levels of a hydrogen atom

SPECTROMETER SPECIFICATION

Design	Constant deviation 120F
Prism type	Pellin Broca (N-SF1)
Refractive index	1.7
Wavelength range	380 - 680nm
Resolution	0.1nm
Input	Micrometer controlled slit as well as fiber coupled (SMA)

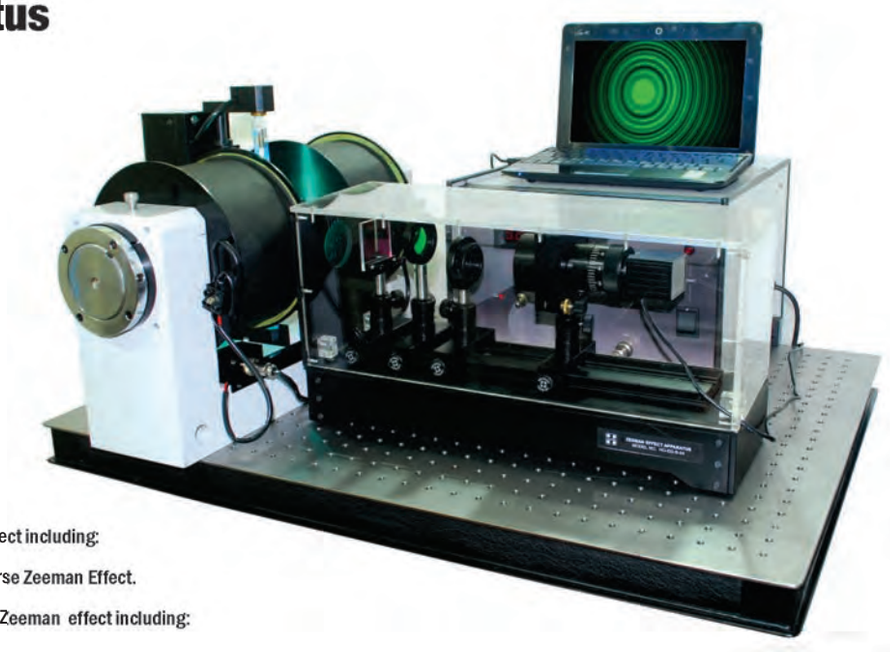
SENSOR SPECIFICATION

CCD sensor	B/W line sensor
Number of pixels	3648
Pixel size	800 x 200 micron
ADC resolution	16 Bits
Exposure time range	0.1ms - 6,500ms
Frame rate	Up to 138 scans/second
Interface	USB 2.0
Compatibility	Windows 7 or higher

Wavelength (nm)	Color
656.2	Red
486.1	Blue
434.0	Blue-violet
410.1	Violet

Zeeman Effect Apparatus

Model No: HO-ED-S-04A



Holmarc's Zeeman Effect Apparatus (Model No : HO-ED-S-04A) is designed for the determination of e/m ratio, which requires knowledge in optics,mechanics, electromagnetism, modern physics and mathematics. Traditional Zeeman effect apparatus needs more skills in operation and measurement. With it's new and integrated design, this device is easier to setup and operate so that students can lay focus on understanding the principles and theories involved.

Experiment Examples:

This experiment consist of two parts:

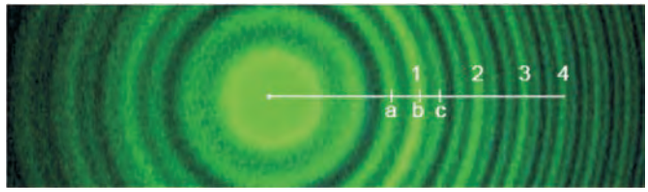
- **To perform qualitative observations of the Zeeman effect including:**
  1. **Observing the line triplet for the normal transverse Zeeman Effect.**
- **To perform quantitative measurements on the normal Zeeman effect including:**
  1. **To find Spacing of the etalon**
  2. **Verification of the magnetic moment constant Bohr magneton(μ)**
  3. **Analysis of Planck's constant (h) and speed of light(c) using Zeeman Effect**
  4. **Calibration of the magnetic field**

A low-pressure mercury lamp is placed inside a variable current electromagnet. Light passes through a narrow-band interference filter (or Dye based filter), centered around the desired wavelength and enters the Fabry - Perot etalon. This device consists of two reflective parallel plates which serve to transmit strong incoming radiation at different orders of wavelength. Small tilting knobs allow precise and careful adjustments of the plate.

The significant difference in our setup is in the imaging system used for viewing and recording the interference patterns. We use USB 2.0 camera, which can be directly connected to the PC to monitor the fringe pattern and save desired pictures. This makes the alignment of the optics much easier and eliminates the need for photographic processing. The Fabry-Perot etalon is the heart of the apparatus which allows us to detect small shifts in wavelengths of light emitted from the source. Basically, it is a pair of parallel, highly reflective mirrors separated by a distance.

ZEEMAN EFFECT APPARATUS - Related Topics

- Bohr's atomic model
- Bohr magneton
- Fabry - Perot interferometer
- Quantization of energy levels
- Interference of electromagnetic waves



GAUSSMETER SPECIFICATION

Range	0 - 20KG
Resolution	10 gauss
Accuracy	+/- 0.5%
Display	3 ½ digit, 7 segment LED
Power	220V +/- 10%, 50Hz
Transducer	Hall probe - InAs

DICHROIC GREEN FILTER SPECIFICATION

Type	Additive
Color	Green
Dimensions (mm)	50 x 50
Clear aperture (%)	≥85
Thickness (mm)	2 nominal
Surface quality	80 - 50
Angle of incidence (°)	0
Substrate	BOROFLOAT

Scope of supply	Quantity
Rail based platform (Length 500mm)	1 no.
IR filter with mount (50 X 50mm)	1 no.
Green filter with mount (50X50mm)	1 no.
Polarizer with variable aperture (Rotation 360°)	1 no.
Fabri- Perot Etalon with mount (R/T ratio=85/15)	1 no.
Camera lens assembly(FL=65mm)	1 no.
CCD camera	1 no.
Electromagnet (Maxi. magnetic field =1.8 Tesla)	1 no.
Digital gauss meter(Range-0-20KG)	1 no.
Gauss probe holder with mount (Height=100-150mm)	1 no.
Mercury vapour lamp with power supply(230V,50Hz)	1 no.
Dust protecting cover with magnetic locks	1 no.

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Laser Raman Spectrometer (PMT Based)

Model No: HO-ED-S-06

Laser Raman Spectrometer (Model no: HO-ED-S-06) is primarily meant for post graduate courses in Physics and Engineering. It can be used as a laboratory analyzing tool as well.

Monochromator

The monochromator is of Czerny-Turner design with 50 mm x 50mm size plane grating having 1200 lines per millimeter. A sine drive mechanism with classic design is employed for rotation of grating by using a stepper motor. Enhanced aluminium coated concave mirrors are used for collimating the signal light. The monochromator chamber is sealed air tight. No user adjustments required for normal use.

Detector

PMT is used as detector. It is kept near to exit slit in an enclosure. The high voltage power supply required for PMT is made integrated with the detector housing.

Control Electronics and Software

Electronics hardware is made integrated for monochromator, detector and laser source so that fully automatic operation is possible from an interfaced computer. The software developed is dedicated for Laser Raman spectrometer with all standard capabilities. Holmarc's engineers entertain customization of this software on request.

Sample Illumination and signal collection

Sample is illuminated by a laser. Though the instrument is supplied with 532 nm DPSS laser, it can be replaced by any laser of user's choice to suit application requirements. Laser mount and illumination chamber is made compatible for this purpose. Laser is guided to the sample by mirrors mounted on kinematic mounts. Sample can be either liquid or solid. Sample chamber is designed in such a way that liquid in a test tube or solid held on pin can be mounted for illumination. We customize the sample chamber at no extra cost as well. For efficient collection of signals, concave mirror and lenses are incorporated in the sample chamber.

Features:

- Computer-controlled, user-friendly interface.
- Capable of automatic recording of Raman spectra.
- DPSS laser is used as light source.
- Both solid and liquid samples can be analyzed.
- The system is assembled as a standalone unit with a footprint of 800 mm x 600mm.
- High sensitive PMT is used as the detector.
- PMT protection feature.

SPECTROMETER SPECIFICATION

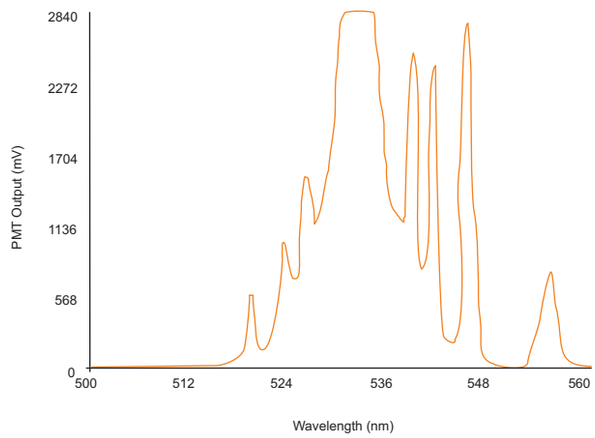
Laser	532nm 40 mW DPSS laser
Wavelength range	200 ~ 800 nm (Monochromator)
Wavelength accuracy	≤ 0.4 nm
Wavelength repeatability	≤ 0.2 nm
Reciprocal of linear dispersion	2.7 mm
Resolution of the slit	0.01mm
Notch filter wave length	532 nm
CWL tolerance (nm)	+/- 5.3 nm
Half-width of spectral line	≤ 0.2nm @ 586nm

MONOCHROMATOR SPECIFICATION

Relative aperture ratio	D/F 1/5.5
Optical grating	1200 l/mm
Slit width	0~2mm continuously adjustable

Experiment Examples:

- To record the vibrational Raman spectrum of CCl_4 molecule.
- To record the polarized Raman spectrum of CCl_4 molecule.
- To calculate the depolarization ratio of CCl_4 molecule and to determine if the mode of vibration is symmetric or asymmetric vibrational Raman mode.
- To record the Raman spectrum of Diamond.
- To record the Raman spectrum of acetone, Iso propanol etc or unknown chemicals.



CCl_4 Spectrum

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Laser Raman Spectrometer (CCD Based)

Model No: HO-ED-S-06A

Highly sensitive (0.1 -6500ms), low noise, cooled CCD is ideal as a detector for Raman spectrum studies. Czerny Turner design is applied in the spectrometer with precision holographic grating as dispersion element. The control electronic devices convert the optical dispersion to electronic pulses which is transmitted to computer via USB .

The software used to interpret the data is user friendly. Regression/curve fit algorithms (Newton- Raphson numerical analysis, Levenberg Marquardt algorithms, etc)are used. Savitzky –Golay filtering/Box car smoothing purposes, etc are the features of the software. Material library is provided for customized versions.

Experiment Examples:

- To record the vibrational Raman spectrum of CCl_4 molecule.
- To record the polarized Raman spectrum of CCl_4 molecule.
- To calculate the depolarization ratio of CCl_4 molecule and to determine if the mode of vibration is symmetric or asymmetric vibrational Raman mode.
- To record the Raman spectrum of diamond.
- To record the Raman spectrum of acetone, Iso propanol etc or unknown chemicals.

Holmarc's CCD Based Laser Raman Spectrometer apparatus (Model No: HO-ED-S-06A) is an apparatus designed for recording Raman spectra of both solids and liquid samples. Raman spectroscopy is a scattering technique. It is based on Raman Effect, i.e., frequency of a small fraction of scattered radiation is different from frequency of monochromatic incident radiation.

It is based on the inelastic scattering of incident radiation through its interaction with vibrating molecules. It probes the molecular vibrations. This will produce a different range of frequencies, namely intense stokes and anti stokes, which have higher frequency than the incident radiation along Rayleigh line. Rayleigh and Raman scattering can be explained both classically and quantum mechanically.

In CCD based Raman spectrometer, sample is kept in cuvette accompanied by the mechanical chamber with DPSS laser (532nm). The vibrational state of molecule while relaxing the high energy state re-emits the radiation in all directions. Spectrometer is positioned in such a way that laser beam collide at the cuvette perpendicularly. Notch filter is used in front of the spectrometer to avoid Rayleigh scattering so that Raman radiations are measured efficiently.

Features:

- Computer-controlled, user-friendly interface.
- Automatic recording of Raman spectra.
- DPSS laser is used as light source.
- Both solid and liquid samples can be analyzed.

SPECTROMETER SPECIFICATION

Design	Czerny Turner design
Type	Plane grating
Lines/mm	1200 l/m
Laser	532nm 40mW DPSS laser
Wavelength range	350-1000nm
Wavelength accuracy	<0.4nm
Wavelength repeatability	<0.2nm
Reciprocal of linear dispersion	2.7mm
Notch filter wavelength	532nm
CWL tolerance (nm)	+/-5.3nm
Calibration source used	mercury lamp
Calibration type	Regression/curve fitting

CCD SPECIFICATION

CCD detector	High sensitive CCD detector 3648 element hermetically sealed vacuum cooled down to -30° C
Signal to noise ratio	500:1
A/D resolution	12/16 Bit
Exposure Time	0.1 - 6500 ms

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Confocal Laser Raman Spectrometer

Model No: HO-ED-S-06B

Holmarc's Confocal Laser Raman Spectrometer couples a Raman spectrometer to a standard optical microscope, allowing highly magnified visualization of a sample and Raman analysis with a microscopic laser spot. In this equipment, sample is placed on the top of the microscope (Inverse confocal method)and is focused and then the measurement is taken. We can also analyze the sample output intensity vs. Raman shift spectrum which is connected via USB on a computer screen.

Experiment Examples:

- To record the Raman spectrum of Solid and liquid samples using spectrometer
- To visualize the live mode of molecule in action and its Studies

Features:

- Computer –controlled, user-friendly interface.
- Capable of automatic recording of Raman Spectra
- DPSS laser is used as light source.
- Both solid and liquid samples can be analyzed.
- System is assembled as standalone unit.

SPECTROMETER SPECIFICATION

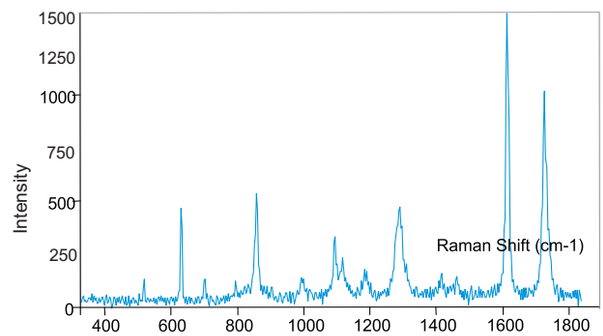
Mirrors	Protective aluminum coated mirrors
Lens	Aspheric achromatic coated mirrors optimized for VIS-NIR range
Microscope	Inverted infinity research grade microscope
Objective	Water immersion 60 X/1.2,with correction collar
Laser	532nm, 40mW DPSS laser
Spectral range	4000~100cm-1(Raman)
Laser spot size	<2microns
The spectral resolution	0.65cm-1
Multimode fibre	Glass core & glass cladding, SMA 905 [FC (Optional]
Wave number accuracy	0.1cm-1

CCD SPECIFICATION

CCD detector	High sensitive CCD detector 3648 element hermetically sealed vacuum cooled down to -30°C
Signal to noise ratio	500:1
A/D resolution	12/16 Bit
Exposure time	0.1 - 6500 ms

Confocal Raman Microscope (CRM)

Confocal means having the same focus. Unlike a normal microscope, where the whole sample is illuminated, the confocal microscope only measures the light from a small volume in the sample at any given time. Raman imaging, which combines Raman spectroscopy and imaging techniques, is an excellent method for obtaining information about the spatial distribution of molecular species. The principle on which Raman Imaging is based, is that the spatial distribution of a molecular species is obtained by isolating the Raman scattered photons from a Raman line of the specific molecular species. Raman Imaging is a 3-dimensional problem (1 spectral and 2 spatial dimensions). In Confocal microscopy we use series-imaging method in which, point illumination technique is used. A laser spot is scanned across the sample. At each resolved position, the light is collected, spectrally filtered and detected by a detector. Confocal Raman microscopy refers to the ability to spatially filter the analysis volume of the sample, in the XY (lateral) and Z (depth) axes.

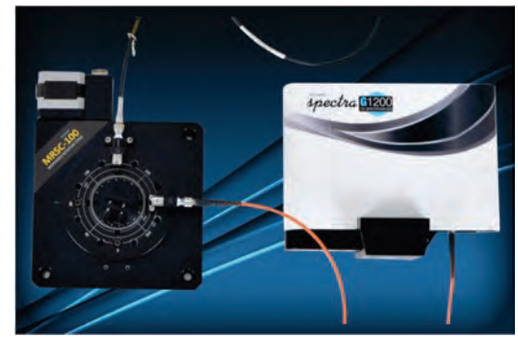


The CG216 & CT216 Series spectrometers are cost-effective high-performance CCD based instruments designed for use with a PC. The standard sensor arrays used in the spectrometer is Toshiba TCD1304DG B/W board-level line CCD camera, based on a single-line, 3648-pixel CCD chip. The array driver electronics has been developed by Holmarc and designed for highly sensitive yet stable operation. More pixel numbers in the sensor makes the CG216 & CT216 Series spectrometers more suitable for the applications requiring high resolution. Thanks to high sensitivity of the CCD, the spectrometer can be used for applications with low light signals as well. It can accept light directly through its built-in slit or via optical fiber. UV spectrometer uses windowless CCD to increase the UV sensitivity down to 200nm. It helps the signal sensitivity below 380nm get improved ~20-50% .

Cg216 CCD Spectrometers Specification

Spectrograph f#	2.9
Optical Platform	Concave Grating
Effective Spectral Range	200 to 1050nm
Spectral Resolution	0.1 to 1nm depending on choices
Slit Options	Micrometer Controlled Variable Slit or 10, 15, 20, 25, 50, 100, 200 or 400μm Fixed Slits
Input Fiber Connector	SMA 905 [FC (Optional)]
Input Fiber NA	0.22
Stray Light	<0.06% @ 532nm (<0.1% overall)
Detector	Toshiba TCD1304AP Linear CCD Array
Pixel Number	3648
Pixel Size	8x200μm
Pixel Well Depth	100,000electron
Signal-to-noise Ratio	1,000:1(at full scale)-
A/D Resolution	16 bit
Integration Time	0.1 to 6,500 ms
Frame Rate	up to 138 fps
Trigger Input	Yes, Optional
PC interface	USB 2.0
Software	Spectra QSR V2.26 (free with spectrometer) Includes DLL libraries and SDKs for easy custom application development

Ct216 Series spectrometer uses f/4 Czerny - Turner design with plane grating, where as CG216 Spectrometer uses f/2.9 concave grating for spectral dispersion. Standard interface to the CG216 & CT216 Series spectrometers is a USB 2.0 compatible with 16-bit extended dynamic range. Software support includes SDK and DLLs for dedicated applications development and Spectra QSR Windows-based spectral acquisition and analysis package.



CG216 / CT216 Series with -30 Degree Cooled CCD

Cooling enables long integration time with low noise values. A three-stage Peltier cooling device integrated into spectrometer sensor can reduce the temperature of the CCD chip by -30 °C against ambient, improving the dark baseline level by a significant factor. The detector cooling also reduces the dark noise by a factor of 2-3. It makes this instrument ideally suited for measuring low light applications like fluorescence.

INTERFEROMETRY

Interference of electro-magnetic radiation is an important phenomena to be closely studied by engineers as well as scientists in a variety of disciplines. Our standard products in interferometry are described in this section. For comprehensive list of our interferometers, please refer our website www.holmarc.com.Though designed primarily for educational needs, all these instruments can be used for research projects as well.

Newton's Rings Apparatus 10
Model No: HO-ED-INT-01

Cornu's Interference Apparatus 11
Model No: HO-ED-INT-02

Michelson Interferometer (Standard Model) 12
Model No: HO-ED-INT-06

Michelson Interferometer (Compact Model) 13
Model No: HO-ED-INT-06C

Magnetostriction with Michelson Interferometer 14
Model No: HO-ED-INT-06M

Michelson Interferometer- Sodium D' Lines 15
Model No: HO-ED-INT-06S

Michelson Interferometer - Piezo Electric Effect 16
Model No: HO-ED-INT-06P

Mach-Zehnder Interferometer 17
Model No: HO-ED-INT-12

Fabry-Perot Etalon 18
Model No: HO-ED-INT-09

Fabry-Perot Interferometer (Projection Based) 19
Model No: HO-ED-INT-10

Fabry-Perot Interferometer (CCD Based) 20
Model No: HO-ED-INT-10A

Fizeau Interferometer 21
Model No: HO-ED-INT-14

Electronic Speckle Pattern Interferometer 22
Model No: HO-ED-INT-15

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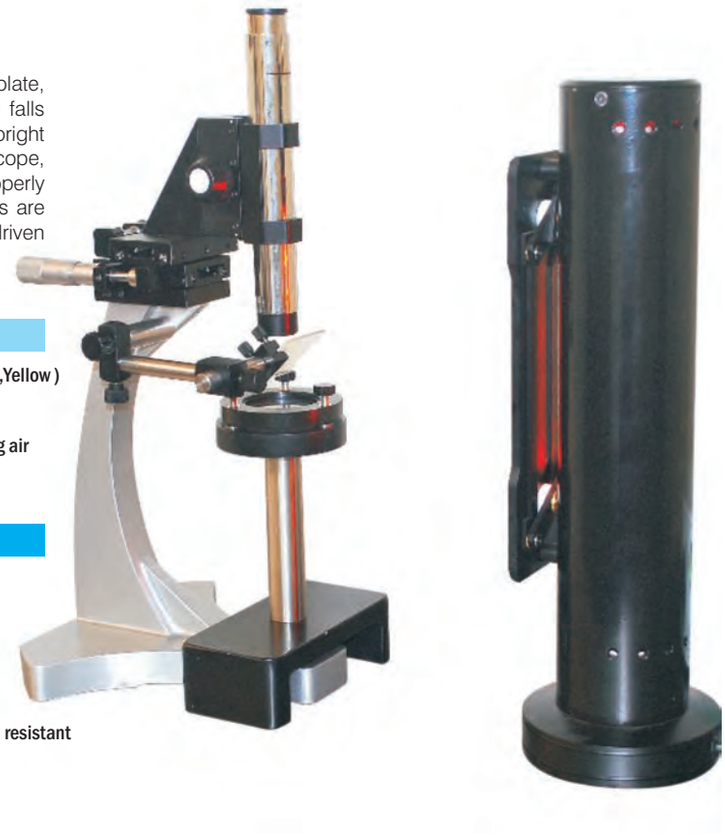
Newton's Rings Apparatus

Model No: HO-ED-INT-01

In this apparatus, light from a sodium lamp falls on the glass plate, inclined at 45 degree to the horizontal, get reflected, and then falls normally on the convex lens placed over the glass plate. A system of bright and dark concentric circular rings are observed through a microscope, arranged vertically above the glass plate. The microscope is properly focused so that alternate bright and dark concentric circular rings are observed more clearly. Measurements are taken from a micrometer driven traveling microscope, which is integrated with this apparatus.



Experiment Examples:

- To determine the wavelength of Sodium light and LEDs (Red,Blue,Green,Yellow)
- To find the refractive index of liquid.
- To find the diameter of thin wire or thickness of a thin strip of paper using air wedge method

Features:

- Sodium vapor lamp and spectral LED's are used as light sources.
- Traveling microscope with precision micrometer is used for accurate measurements.
- The optics used in this device are of research quality.
- All materials used in this setup are of laboratory grade and are corrosion resistant

SPECIFICATION (of travelling microscope)

Magnification	10 X
Micrometer travel	25 mm
Least count	0.01 mm

The two interfering beams, derived from a monochromatic source satisfy the coherence condition for interference. Ring shaped fringes are produced by the air film existing between the convex surface of a long focus planoconvex lens and the plane of glass plate.

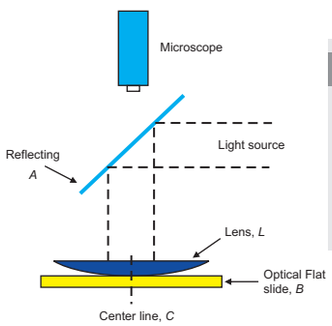


Fig: Newton's Rings Setup

NEWTON'S RING APPARATUS - Related Topics

- Interference of light
- Constructive Interference
- Destructive interference
- Refractive index
- Boy's method

Scope of supply — Quantity

Travelling microscope with rigid base (10X)	1 no.
Lens holder with rigid base (Height 180mm)	1 no.
LED mount with rigid base (Height 225mm)	1 no.
Plano convex lens (FL=1000mm,750mm)	1 no each
Optical flat(Dia=50mm)	1 no.
Beam splitter plate(size=45X45 mm)	1 no.
Sodium vapor lamp with power supply	1 no.
LEDs with power supply(Red, Blue , Green, Yellow)	1 no each

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Cornus Interference Apparatus

Model No: HO-ED-INT-02

This device is similar to Newton's Rings apparatus, except that an arrangement for loading the test piece is provided for carrying out Cornus interference studies. The objective of this experiment is to determine Poisson's ratio and Young's Modulus for different materials (glass, Perspex etc) using interference method. Weights are positioned at both ends of the bar, causing it to bend longitudinally downward. A glass plate is placed on the bar to produce an interference pattern. By examining the interference pattern, extent of longitudinal and lateral bending can be determined. Thus, Poisson ratio and Young's modulus of the bar can be deduced.

Experiment Examples:

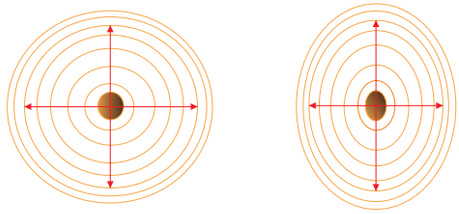
- To study the elastic constants of glass by Cornus interference methods,
  - Hyperbolic fringes
  - Elliptical fringes

Features:

- In this apparatus, sodium vapor lamp and spectral LED's are used as light sources.
- Traveling microscope with precision micrometer is used for accurate measurements
- High quality optics are used in order to get the clear fringe pattern
- All materials used in this setup are of laboratory grade and are corrosion resistant.

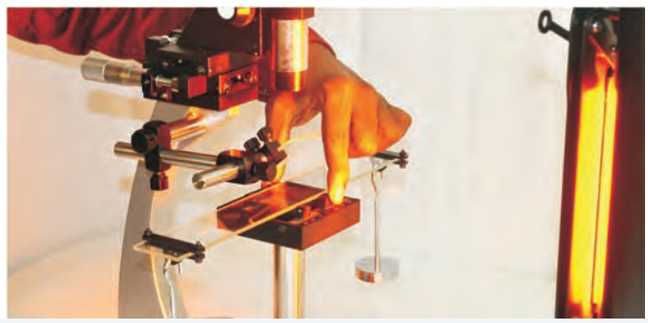
SPECIFICATION (of travelling microscope)

Magnification	10X
Micrometer travel	25 mm
Least Count	0.01 mm



W = 0 W = m_1g

When a plano-convex lens rests on a uniformly bent glass bar, an air film is formed between the two surfaces. Without adding any mass in the weight hanger we get circular rings. But as we uniformly add mass on the weight hangers, the beam bends and we get elliptical fringes.



CORNUS INTERFERENCE APPARATUS - Related Topics

- Young's Modulus
- Poisson's ratio
- Rigidity Modulus
- Bulk Modulus

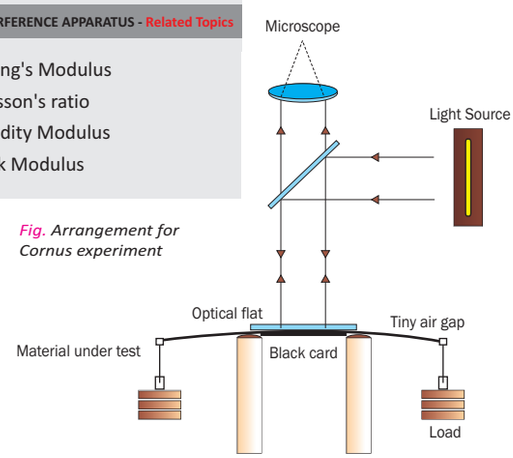


Fig. Arrangement for Cornus experiment

Scope of supply	Quantity
Travelling microscope with rigid base (10X)	1 no.
Knife edges with rigid base (Height 180mm)	1 no.
Lens holder with rigid base (Height 225mm)	1 no.
Weight hanger clamp (Length 5mm)	1 no.
Weight hangers with weights (Brass)	1 no.
Plano convex lens (Focal Length 1000mm)	1 no.
Plano convex lens (Focal Length 750mm)	1 no.
Beam splitter plate(size=45X45mm)	1 no.
Optical flat(Dia=45mm)	1 no.
Test samples(Borofloat glass , PMMA)	1 no each.
Sodium vapor lamp with power supply	1 no.
LED's with power supply(Red, Blue , Green, Yellow)	1 no each

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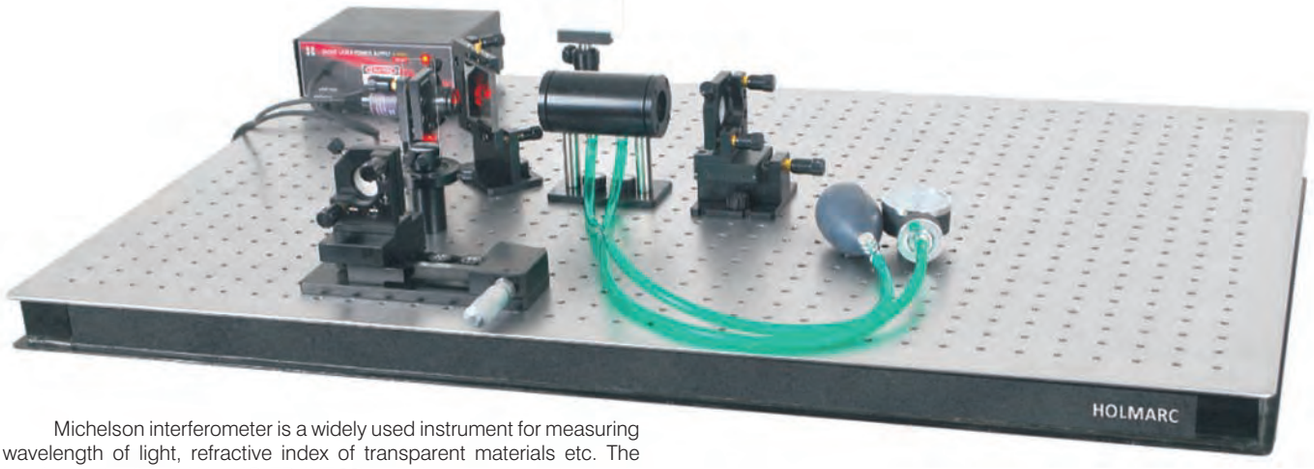
Michelson Interferometer (Standard Model)

Model No: HO-ED-INT-06



Michelson interferometer is a widely used instrument for measuring wavelength of light, refractive index of transparent materials etc. The interferometer (Model No. HO-ED-INT-06) is designed and constructed in modular fashion. The beam splitter is designed to reflect 50% of the incident light and transmit the other 50%. The incident beam therefore is split into two beams; one beam is reflected towards mirror M_1, the other is transmitted towards mirror M_2 . Half the light is transmitted through the beam splitter to M_1 and the other half is reflected by beam splitter to M_2. The reflected beams from $M_1$and M_2 superimpose at the beam splitter and the interference pattern can be observed on the screen.

Experiment Examples:

- To determine wavelength of laser beam.
- To find refractive index of a transparent material.
- To study refractive index change in air under different pressures and determination of refractive index of air.

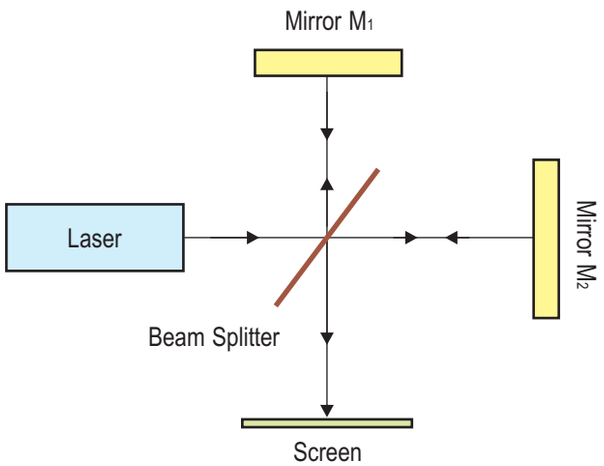
MICHELSON INTERFEROMETER STANDARD - Related Topics

- Interference of light
- Constructive Interference
- Destructive interference
- Wavelength of light
- Refractive index

Maximum pressure in the pressure gauge is 300mm Hg

Features:

- The instrument uses laser diode as light source
- Precision kinematic mounts for optical components.
- The optics used in this device are of research quality
- The assembling and alignments are easy, can assemble individually.



Scope of supply	Quantity
Optical Breadboard with support (800mm x 600mm)	1 no.
Kinematic laser mount	1 no.
Mirror mount with translation	1 no.
Mirror mount with precision translation	1 no.
Rotation stage(Resolution 2° / division)	1 no.
Screen with mount (Dimension 75x75mm)	1 no.
Pressure cell (Pressure Range =0-300 mm Hg)	1 no.
Mirror with cell (Borofloat)	2 nos.
Beam splitter (size=50X50X4mm)	1 no.
Glass slide (Float)	5 nos.
Diode laser with power supply(650nm)	1 no.
Diode laser with power supply (532nm)	1 no.

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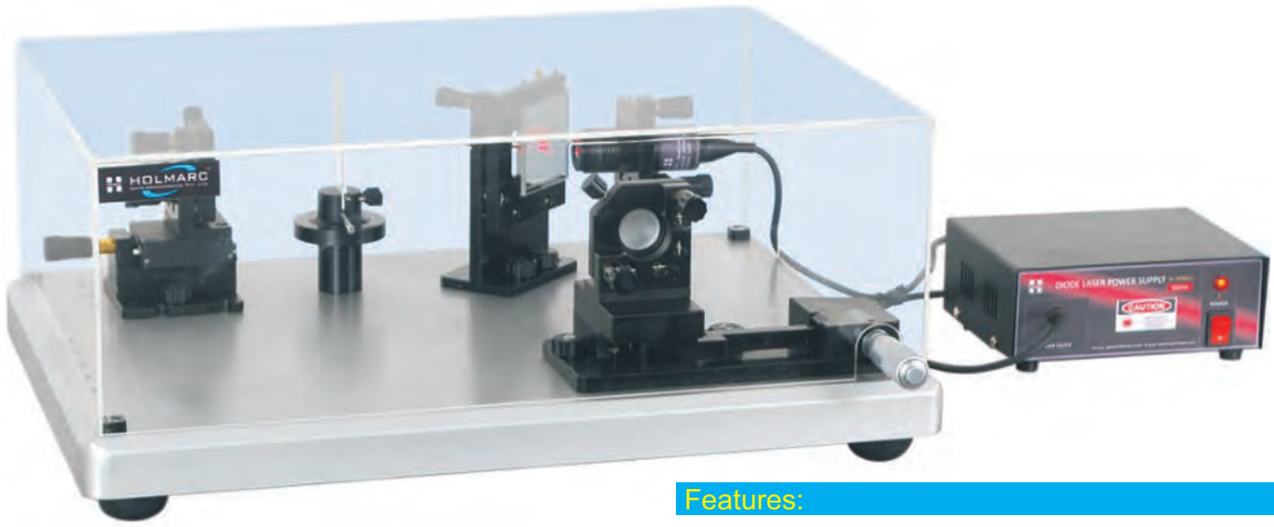
Michelson Interferometer (Compact Model)

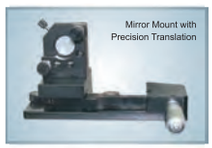
Model No: HO-ED-INT-06C

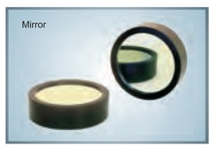


Holmarc's Model No: HO-ED-INT-06C is a compact Michelson Interferometer. The beam splitter is designed to reflect 50% of the incident light and transmit the other 50%. The incident beam therefore is split into two beams; one beam is reflected towards mirror M_1, the other is transmitted towards mirror M_2 .Half the light is transmitted through the beam splitter to M_1 and the other half is reflected by beam splitter to M_2. The reflected beams from $M_1$and M_2 superimpose at the beam splitter and interference pattern can be observed on the screen.

Experiment Examples:

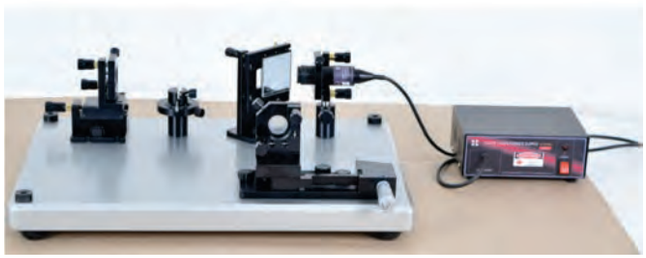
- To determine wavelength of laser beam
- To find refractive index of a transparent material





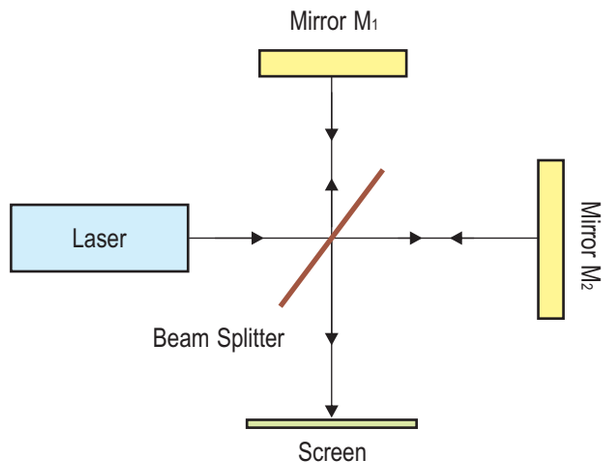
MICHELSON INTERFEROMETER COMPACT MODEL - Related Topics

- Interference of light
- Constructive Interference
- Destructive interference
- Wavelength of light
- Refractive index



Features:

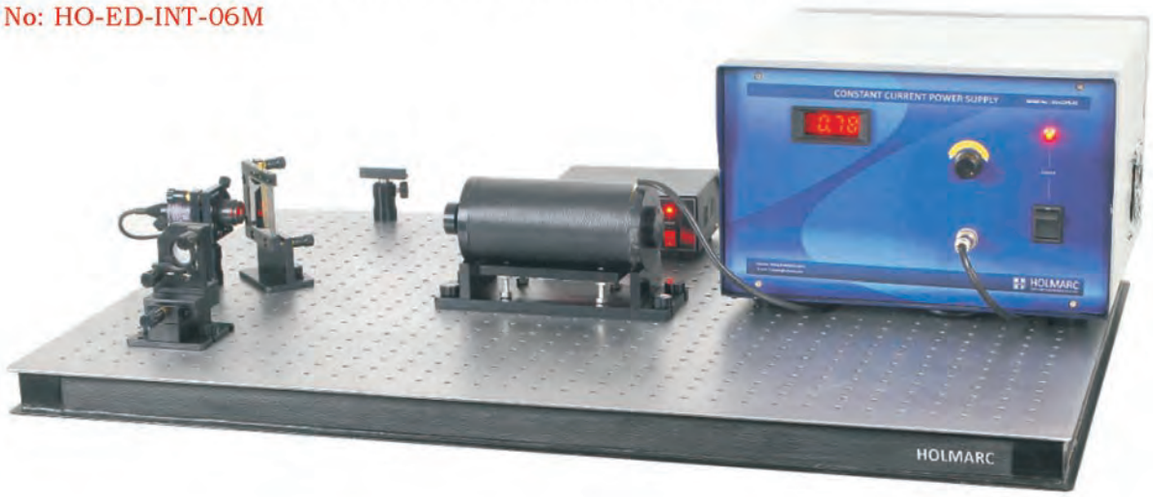
- The distance between the mirrors and beam splitter is fixed.
- The components are mounted on a rigid platform.
- The instrument uses laser diode as light source
- Precision kinematic mounts for optical components.
- The optics used in this device are of research quality



Scope of supply	Quantity
Rigid base platform(450 x 325 mm)	1 no.
Kinematic laser mount	1 no.
Beam splitter mount	1 no.
Mirror mount with precision translation	1 no.
Mirror mount with translation	1 no.
Rotation stage(Resolution 2° / division)	1 no.
Mirror with cell (Borofloat)	2 nos.
Beam splitter (Dimension 50mm x 50mm)	1 no.
Glass slide (Float)	5 nos.
Diode laser with power supply(650nm)	1 no.

Magnetostriction with Michelson Interferometer

Model No: HO-ED-INT-06M



Holmarc's Model No:HO-ED-INT-06M, Magnetostriction with Michelson Interferometer uses two mirrors in a Michelson arrangement to obtain the interference pattern. Due to the magnetostrictive effect, one of the mirrors is shifted by variation in the magnetic field applied to the sample, and the shift in interference pattern is observed.

MAGNETOSTRICTION WITH MICHELSON INTERFEROMETER - Related Topics

- Magnetostriction - positive and negative magnetostriction.
- Ferro magnetism
- Interference of light

Features:

- **Longitudinal magnetostriction is considered.**
- **All materials used in this setup are of laboratory grade and are corrosion resistant**
- **Diode laser is used as light source**

SPECIFICATION (of electromagnet)

Length of the coil	150 mm
Winding material	Copper
No. of turns	2508 nos.

Ferromagnetic substances undergo so-called magnetic distortions, i.e, they exhibit lengthening or shortening parallel to the direction of magnetization. Such changes are termed positive or negative magnetostriction. In crystal anisotropy , magnetostriction is also ascribable to the spin-orbit mutual potential energy, as this is a function of direction of magnetization and the interatomic distances. Due to magnetostriction, which corresponds to a spontaneous distortion of the lattice, a Ferro magnet can reduce its total anisotropic and elastic energy.

Experiment Example:

- **To study magnetostrictive properties of various materials (iron, nickel, and copper).**

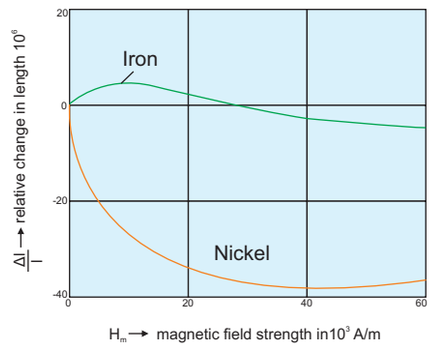


Fig:- Magnetostriction of different ferromagnetic materials with their relative change in length Δl plotted against applied magnetic field strength Hm

Scope of supply	Quantity
Optical breadboard with support(800 x 600 mm)	1 no.
Kinematic laser mount	1 no.
Beam splitter mount	1 no.
Mirror mount with translation	1 no.
Mirror with cell (Borofloat)	2 nos.
Beam splitter (N-BK7)	1 no.
Diode laser with power supply(wavelength 650nm)	1 no.
Electromagnet coil with Mount	1 no.
Screen with mount	1 no.
Specimen rods (Iron, Nickel, Copper)	1 no each.
Electromagnet power supply(I=0-4A)	1 no.

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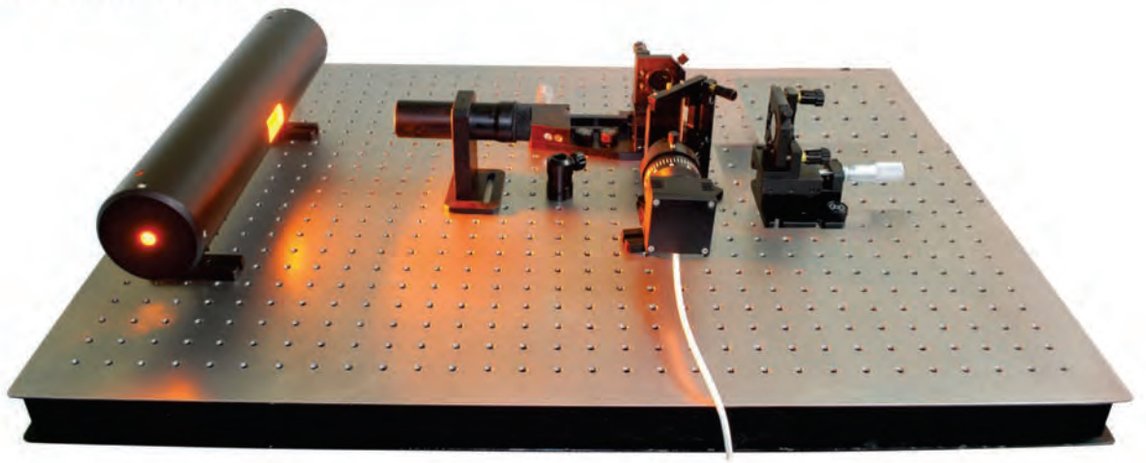
Michelson Interferometer (Sodium D' Lines)

Model No: HO-ED-INT-06S



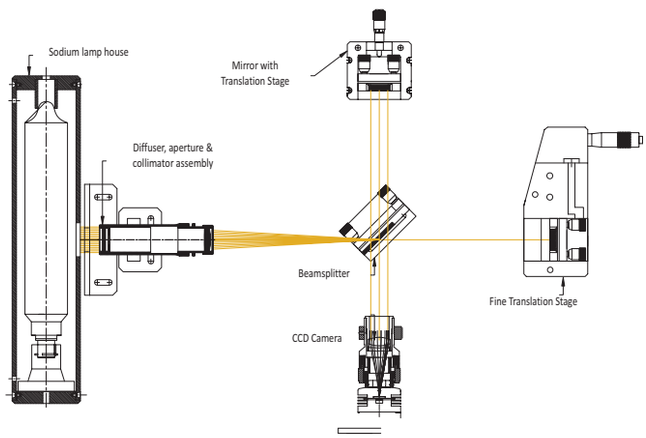
In this model of Michelson interferometer, sodium vapor lamp is used as light source. Sodium has two emission wavelengths that have extremely close values and without sensitive equipment, it cannot be distinguished. Measurement of these lines, designated as D_1 and D_2 Fraunhofer lines, the average wavelength as well as difference between the two emission lines of sodium can be determined. The purpose of this experiment is to measure the wavelength of Sodium D emission lines.

Experiment Examples:

- To find out the difference in wavelength of D_1 and D_2 lines of sodium light
- To determine the wavelength of monochromatic light
- To measure refractive index of transparent materials

MICHELSON INTERFEROMETER - Related Topics

- Interference of light
- Refractive index
- Wavelength
- D_1 and D_2 Fraunhofer lines



Features:

- Sodium vapor lamp and diode laser is used
- Mirrors and beam splitter are mounted on precision kinematic mounts for fine tuning and alignment
- CCD camera is used
- Computer interfaced

The two beams of a Michelson interferometer interfere constructively when the waves add in phase and destructively when they add out of phase, producing circular interference fringes as a result. From this we can calculate wavelength of sodium source. The interference pattern observed with the sodium lamp contains two sets of fringes which disappear when the bright bands of one set are superimposed on the dark bands of the other. The wavelength separation of the Na D-line doublet is easily determined by observing the successive coincidence and discordance of the two sets of fringe systems produced by the doublet of wavelengths (λ_1 and λ_2 with $\lambda_1 > \lambda_2$). As D is increased, the two systems gradually separate and the maximum discordance occurs when the rings of one system are set exactly halfway between those of the other system. The discordance positions are most clearly seen as minima in the contrast of the pattern.

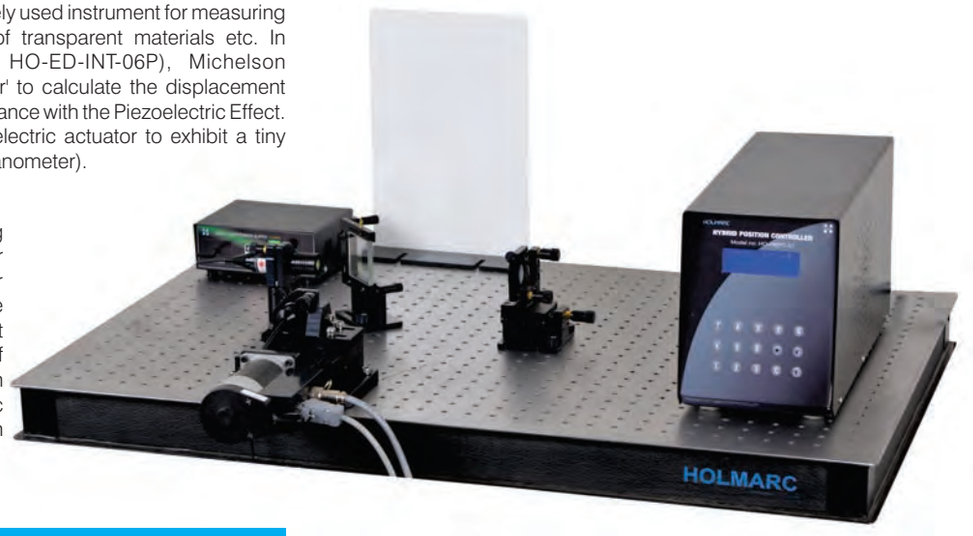
Scope of supply	Quantity
Optical Breadboard with support(800X600mm)	1 no.
Kinematic laser mount	1 no.
Beam splitter mount	1 no.
Mirror mount with precision translation	1 no.
Mirror mount with translation	1 no.
Rotation stage(Resolution 2° / division)	1 no.
Camera lens assembly mount(Dia=50mm)	1 no.
Diffuser disc with mount	1 no.
Camera lens assembly(Focal length=65mm)	1 no.
Mirror with cell (Borofloat)	2 nos.
Beam splitter (N-BK7)	1 no.
Glass slide (Float)	5 nos.
Diode laser with power supply(650nm)	1 no.
Sodium vapor lamp with power supply	1 no.
CCD camera	1 no.

Michelson Interferometer (Piezo Electric Effect)

Model No: HO-ED-INT-06P

Michelson interferometer is a widely used instrument for measuring wavelength of light, refractive index of transparent materials etc. In Holmarc's Apparatus (Model No: HO-ED-INT-06P), Michelson Interferometer is used as 'Optical Ruler' to calculate the displacement factor of piezoelectric actuator in accordance with the Piezoelectric Effect. An applied voltage will cause a piezoelectric actuator to exhibit a tiny mechanical displacement(typically in nanometer).

The displacements are measured using the beam of light from a diode laser (650nm) in the Michelson Interferometer to calculate the minute motions. The applications of the Piezoelectric effect has reached almost every fields of science and technology, being utilized in advanced disciplines such as the atomic force microscopy, all forms of vibration suppression etc.



Features:

- Research grade optical components
- Flexible, modern and user friendly design
- Precision kinematic mounts for fine tuning and alignment

Piezoelectric Actuators

A piezoelectric actuator converts an electrical signal into a precisely controlled physical displacement (stroke). If displacement is prevented, a useable force (blocking force) will develop. The precise movement control afforded by piezoelectric actuators is used to finely adjust machining tools, lenses, mirrors, or other equipment. Piezoelectric actuators are also used to control hydraulic valves, acting as small-volume pumps or special-purpose motors and in other applications requiring movement or force. When an electric field is applied across the material, the polarized molecules will align themselves with the electric field, resulting in induced dipoles within the molecular or crystal structure of the material. This alignment of molecules will cause the material to change dimensions. This phenomenon is known as electrostriction. This can be utilized by engineers to develop instruments for measuring exact displacement factors. They can use this knowledge to apply exact voltages and produce nanometer displacements with an incredibly small margin of error. Knowing this is immensely important, especially in the ever growing field of nano-technology, where the smooth movement of a piezo electric actuator would be able to move minute parts and manufacture tiny materials.

Features of Piezo Electric Actuator

- Compact size, accurate positioning in nm, high speed response and large blocking force.
- High energy conversion efficiency, low power consumption and absence of electromagnetic noise.
- Easy to be controlled by voltage variations.

Experiment Examples:

- To observe the Piezo Electric Effect
- To obtain the displacement factor by counting the fringe shift

Holmarc's Michelson Interferometer-piezoelectric effect uses two mirrors in a Michelson arrangement to obtain the interference pattern. The interferometer is assembled with a Piezoelectric Actuator on a movable mirror. When the voltage across the Piezoelectric Actuator is increased from zero to maximum gradually, we can observe shift in the fringe pattern. One can determine the fringe shift and hence the displacement produced by the Piezoelectric Actuator can be calculated.

The instrument uses laser diode as light source. Assembly and alignment are easy to understand. Laser, mirrors and beam splitter are mounted on precision kinematic mounts for fine tuning and alignment. The interference fringes are obtained on a screen and can be viewed with naked eye. Due to the Piezoelectric Effect, one of the mirrors is shifted by the variation in the voltage applied to the sample, and the change in interference pattern is observed. Students can assemble the interferometer out of individual modules by fixing them on the optical breadboard. All components required for such assembly, including screws and allen keys, are supplied with the package.

Scope of supply	Quantity
Optical breadboard with support(800x 600 mm)	1 no.
Kinematic laser mount	1 no.
Kinematic beam splitter mount	1 no.
Mirror mount with translation	1 no.
Mirror mount with Piezo electric actuator	1 no.
Power Supply for Piezo electric actuator	1 no.
Screen with mount	1 no.
Beam splitter(Dimension 50 x 50 mm)	1 no.
Mirrors with cell(Borofloat)	1 no.
Diode laser with power supply(650nm)	1 no.

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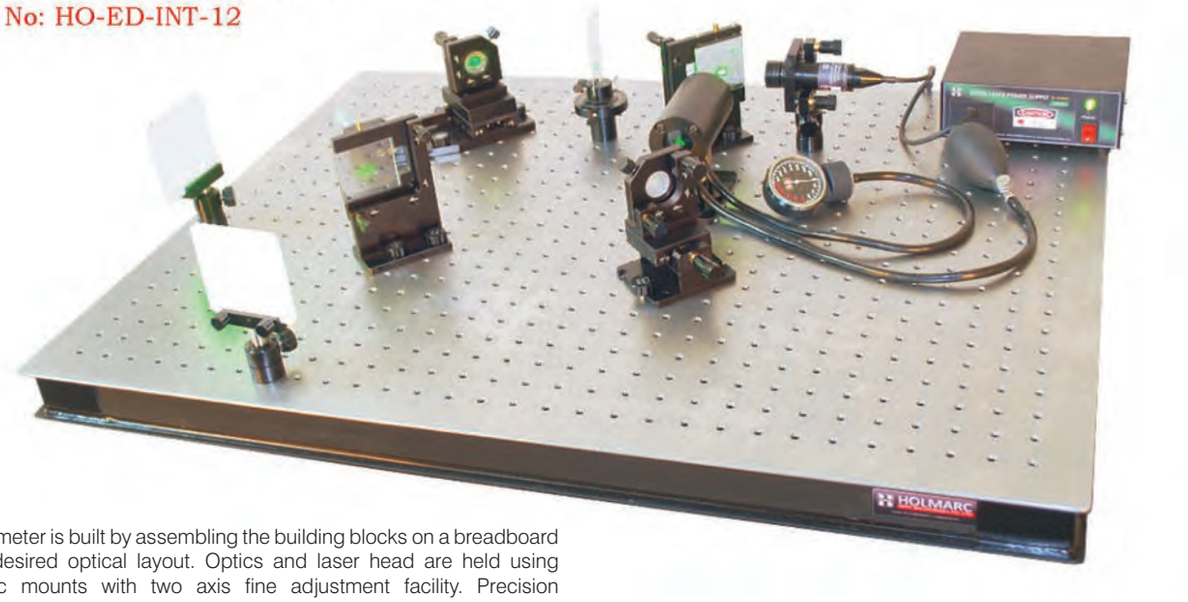
Mach Zehnder Interferometer

Model No: HO-ED-INT-12



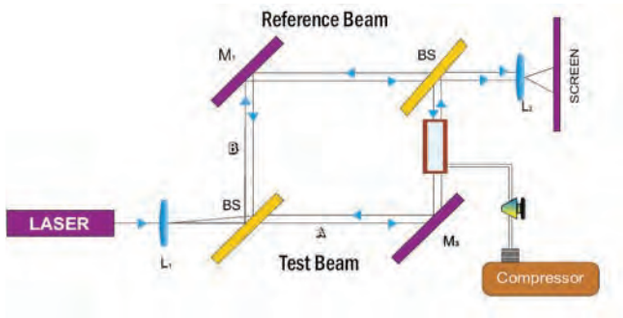
Interferometer is built by assembling the building blocks on a breadboard as per desired optical layout. Optics and laser head are held using kinematic mounts with two axis fine adjustment facility. Precision alignments for obtaining the interference fringes are done using kinematic mounts.

Experiment Examples:

- To determine wavelength of laser beam.
- To find refractive index of a transparent material.
- To study refractive index change in air under different pressures and determine refractive index of air.

Features:

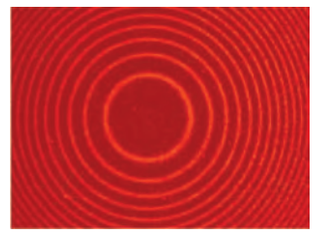
- Kinematic mounts are used for fine movement of optical components .
- Diode laser is used as light source.
- All materials used in this setup are of laboratory grade with corrosion resistance
- The optics used in this device are of research quality.

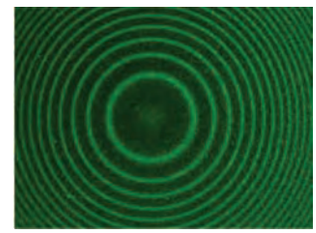


MACH ZEHNDER INTERFEROMETER - Related Topics

- Interference of light
- Constructive Interference
- Destructive interference
- Wavelength of light
- Refractive index

One of the simplest experiments using the interferometer is measurement of index of refraction of air with an airtight test cell placed in one of the optical arms of the interferometer. No other factor such as convective airflow, should be present, that can generate optical path differences. The flexibility in fringe localization is one of the important advantages of the mach zehnder interferometer over other interferometers. Although many Mach-Zehnder interferometers use a rectangular arrangement, parallelogram arrangements are also possible. Vibration isolated supports for optical table is optional.





Scope of supply	Quantity
Optical Breadboard with support(800X600mm)	1 no.
Kinematic laser mount	1 no.
Beam splitter mount	1 no.
Mirror mount with precision translation	1 no.
Mirror mount with translation	1 no.
Rotation stage(Resolution 2° / division)	1 no.
Screen with mount (75X75mm)	1 no.
Pressure cell(Range=0-300mmHg)	1 no.
Mirror with cell(Dia=25mm)	2 nos.
Beam splitter (R/T ratio=50/50)	2 nos.
Glass slide (75mmX25mm)	5 nos.
Diode laser with power supply(Red and Green)	1 no each.

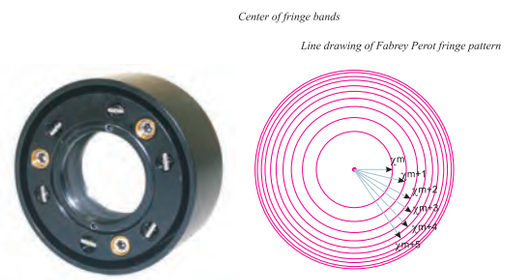
Fabry - Perot Etalon

Model No: HO-ED-INT-09

Holmarc's Fabry-Perot etalon is made of plate beamsplitters separated by 3mm distance. The beamsplitters are made by coating thin aluminum films on optically polished N-BK7 substrates. The reflecting surfaces are kept inside the assembly. The etalon has optical resonating properties similar to that of laser. A translucent screen is provided with vernier and needle to take the readings of the fringes directly.

Experiment Examples:

- To find the Spacing of the Etalon
- To find the Finesse and Free Spectral Range of the Etalon



Fabry Perot etalon produces sharp interference peeks.

Etalons transmit light as a series of periodic frequencies and their narrow bandwidth makes them well-suited for wavelength selection, measurement and line-narrowing. The properties of an etalon are largely determined by its thickness, index of refraction and the reflectivity of it's surfaces. The finesse is a measure of the interferometer's ability to resolve closely spaced spectral lines.

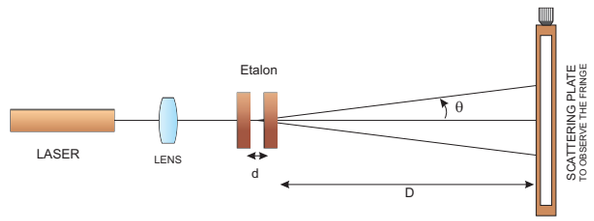
Features:

- Extended durability
- Easy to operate
- Precision design
- Highly polished etalon

An etalon is an optical interferometer in which a beam of light undergoes multiple reflections between two reflecting surfaces and it's resulting optical transmission (or reflection) is periodic in wavelength. In other words, an etalon is a narrow band wavelength filter.

FABRY PEROT ETALON - Related Topics

- wavelength
- Finesse
- Free Spectral Range
- Interference of light



Scope of supply	Quantity
Optical rail (Length 1000mm)	1 no.
Fabri - perot etalon (Spacing of plates 3+/- 1 mm)	1 no.
Kinematic laser mount	1 no.
Plano convex lens with mount(Diameter 20mm)	1 no.
Diode laser with power supply (650nm)	1 no.
Diffuser screen with measurement unit	1 no.
White screen(Acrylic)	1 no.

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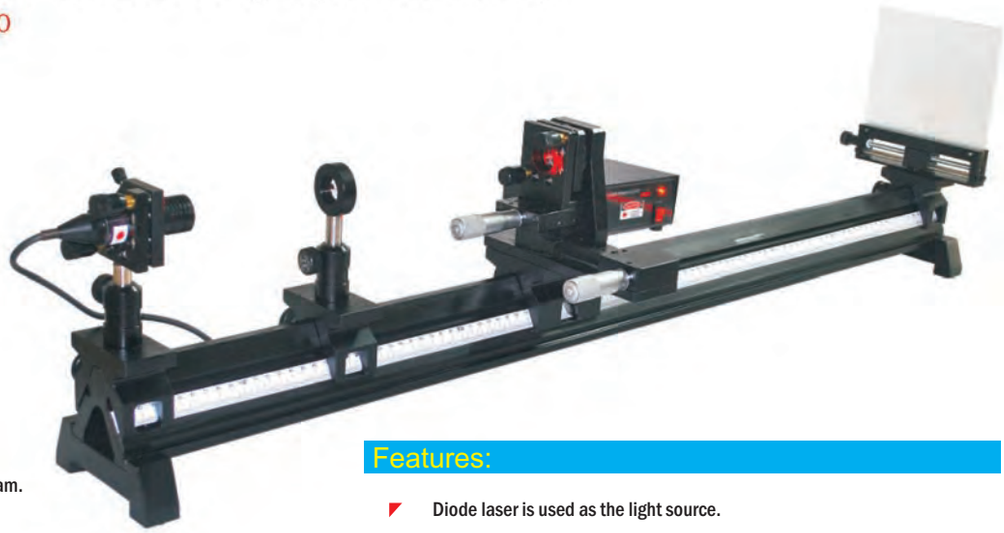
Fabry - Perot Interferometer (Projection based)

Model No: HO-ED-INT-10

In Fabry - Perot interferometer, the distance between the partially reflecting mirrors are varied by using coarse and finely adjustable translation stage driven by micro-meters. One beam splitter is fixed and the other is mounted on the translation stage through a kinematic mount. This two axis kinematic mount is used to correct the parallelism between beamsplitters.



Experiment Examples:

- To find the wavelength of laser beam.
- To find the spacing of the Etalon.
- To find the finesse and Free Spectral Range of the Etalon.

The Fabry - Perot design contains plane surfaces that are partially reflecting so that multiple rays of light are responsible for the creation of the observed interference patterns. For high resolution spectroscopy, where a resolution in the range of MHz to GHz is required, a Fabry - Perot interferometer (FP) is used. The FP consists of two plane mirrors mounted accurately parallel to each another, with an optical spacing of 'd' between them.

The enclosed air gap generally varies from several millimeters to centimeters, when the device is used interferometrically. If the gap can be mechanically varied by moving one of the beam splitters, then the device is referred to as an interferometer. It's transmission spectrum as a function of wavelength exhibits peaks of transmission corresponding to resonances of the etalon. Fabry - Perot interferometers are widely used in telecommunication, lasers and spectroscopy for controlling and measuring the wavelength of light.

FABRY - PEROT ETALON PROJECTION BASED - Related Topics

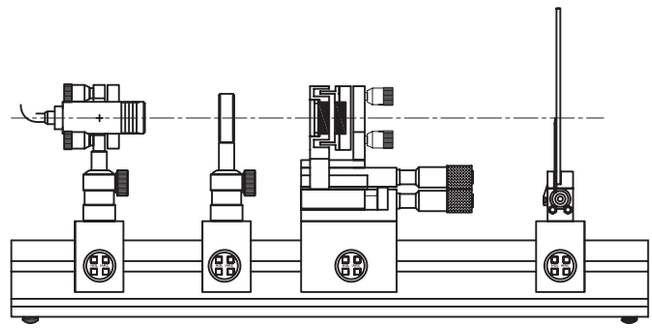
- Spectral range
- Wavelength
- Resolving power
- Finesse of etalon
- Interference

Features:

- Diode laser is used as the light source.
- The mechanical assembly is made out of corrosion free materials.
- All components and modules are mounted on rail by carriage system for easy adjustment.
- The optics and mechanics used are of research quality.

Fabry - Perot Interferometer – Spectral Range.

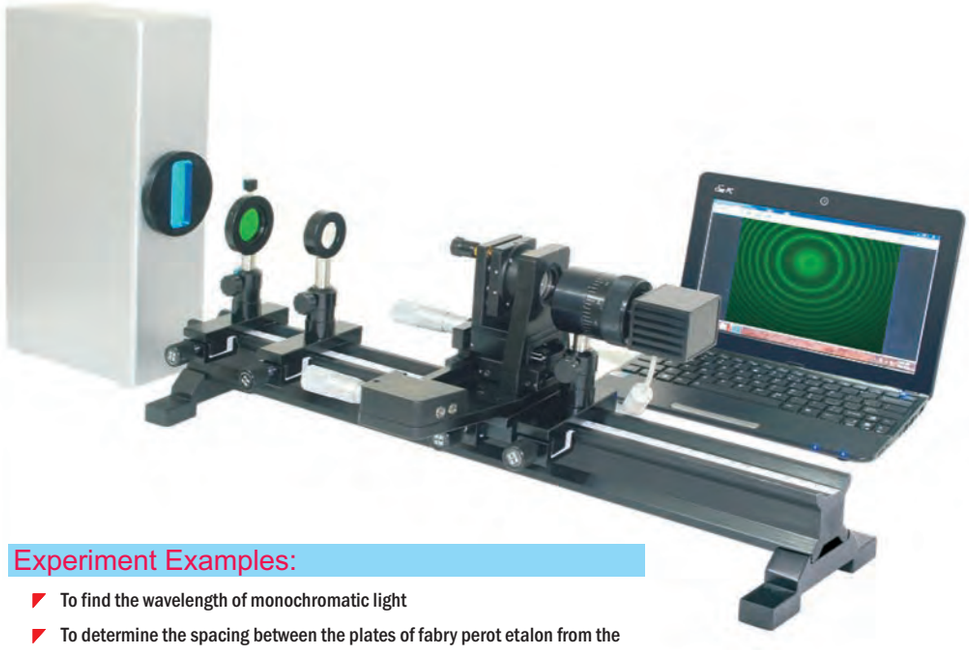
- If two wavelengths are very close, their fringe maxima may overlap
- The two peaks will be distinguishable if the two wavelengths are too close
- A separation of full width at half maximum (FWHM) corresponds to minimum separation between the wavelength components



Scope of supply	Quantity
Optical rail (Length 1000mm)	1 no.
Fabri - perot interferometer (Spacing of plates 3+/- 1 mm)	1 no.
Kinematic laser mount	1 no.
Plano convex lens with mount(Diameter 20mm)	1 no.
Diffuser screen with measurement unit(Float)	1 no.
White screen(Acrylic)	1 no.
Diode laser with power supply (650nm)	1 no.
Diode laser with power supply (532nm)	1 no.

Fabry - Perot Interferometer (CCD Based)

Model No: HO-ED-INT-10A



Computer interfaced Fabry-Perot interferometer(Model No:HO-ED-INT-10A) is similar to projection type (model no:HO-ED-INT-10), apart from the fact that in this case, the interference pattern is captured by a CCD sensor and displayed on a computer monitor. The advantage of computer interface is that the pattern can be saved for future analysis. In addition, measurements can be taken directly from the monitor by using the software module provided.

FABRY - PEROT ETALON CCD BASED - Related Topics

- Interference of light
- Fabry Perot etalon
- Finesse of etalon

Experiment Examples:

- To find the wavelength of monochromatic light
- To determine the spacing between the plates of fabry perot etalon from the fringe Pattern .
- To find the finesse and free spectral range (FSR) of etalon from the fringe calibration at different cavity thickness

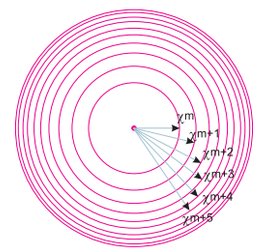
SPECIFICATION OF ETALON

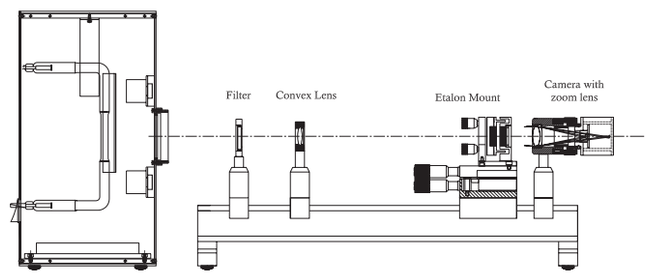
- Spacing of Etalon 2-8mm
- Ratio R/T 80/20
- Aperture 25mm

In the etalon, distance between partially reflecting mirrors can be precisely varied in microns. One of the beam splitters can be kinematically adjusted for initial settings.

Features:

- Mercury vapor lamp is used as light source
- Compact design
- Fine tuning is possible in etalon
- High resolution CCD camera





Scope of supply	Quantity
Optical rail (Length 500mm)	1 no.
Fabri - perot interferometer (25mm Dia)	1 no.
Colour filter mount(30mm Dia)	1 no.
Kinematic laser mount(+/-4 degree adjustable)	1 no.
Camera lens assembly with mount(65mm focal length)	1 no.
Colour filters(Green and Blue)	1 No each.
CCD camera(SelectableResolution)	1 no.
Diode laser with power supply (650nm)	1 no.
Mercury vapor lamp with power supply(230V, 50Hz)	1 no.
Plano convex lens with mount (Dia=30mm,FL=26mm)	1 no.

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Fizeau Interferometer

Model No: HO-ED-INT-14

Fizeau Interferometer is one of the simplest and most versatile interferometers and is popular for routine measurements of both flat and spherical surfaces. It is used to measure optical components such as flats, prisms, lenses, or precision metal parts such as bearings, sealing surfaces or polished ceramics. Measurements can be made by using the static fringe analysis software.

SPECIFICATION

Sample size	≤ 100 mm
Reference flat	λ/20 P V 100 mm diameter 25 mm thickness
Accuracy	≤ λ/20 PV
Laser source	DPSS 5.0 mW 532 nm
Alignment	By Tip / tilt sample base
Camera	CCD Res. 1280 x 1024
Analysis	Using fringe analysis software
Weight	Approx. 25Kg
Power supply	220V, 50Hz

FIZEAU INTERFEROMETER - Related Topics

- Optical flatness
- P-V flatness
- RMS flatness
- Interferogram
- Strehl ratio

The reflection flats and reference spheres are optional. Custom solutions are also possible on request.

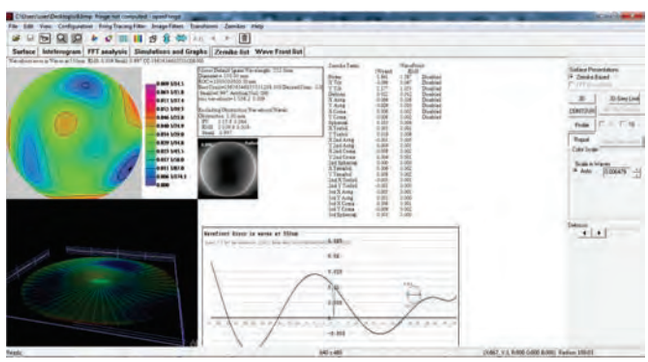
The Holmarc Fizeau interferometer (model no:HO-ED-INT-14) basically comes with high optical quality (λ/20) reference flat. The reflection from the test surface interferes with the reflection from reference flat, producing fringes. The shape and quality of the fringes depends on surface quality of the test flat. The fringes are digitalized using a high resolution CCD camera. By analyzing the fringes, we can obtain the P-V flatness, RMS flatness, 3D surface plot etc. The instrument is built upright to fix the test sample easily. The tip /tilt test base allows the test sample to align with the reference surface. High quality aberration corrected optical design enhances performance.

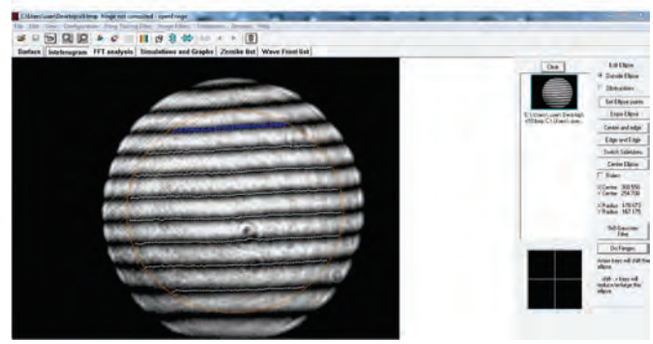
Experiment Example:

- To measure the optical flatness of different surfaces

Features:

- High precision flatness measurement is possible
- Static fringe analysis software is used
- The instrument is built upright, so the test sample can be fixed easily
- High quality aberration corrected optical components are used





Scope of supply	Quantity
Fizeau interferometer(Height 1200mm)	1 no.
Spatial filter assembly(60X)	1 no.
Beam splitter	1 no.
Achromatic doublet with mount	1 no.
Reference flat with mount	1 no.
Test flat with mount	1 No each.
Camera lens assembly(FL=65mm)	1 no.
DPSS laser(532nm)	1 no.
CCD camera(1280X1024 Pixels)	1 no.

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Electronic Speckle Pattern Interferometer (ESPI)

Model No: HO-ED-INT-15

Electronic Speckle Pattern interferometry (ESPI) is a non-destructive optical method for studying surface deformations. It relies on the interference between diffusely reflected light from the test object and a reference beam.This is one of the most sensitive interferometric technique, so that we can measure sub-micron level displacements either in plane or out of plane. The images before and after deformation are recorded by a CCD camera and analysed using an image analysis software. Deformation causes variations in the fringe pattern.These variations can be analized with the help of the software provided to find the deformations.

Experiment Example:

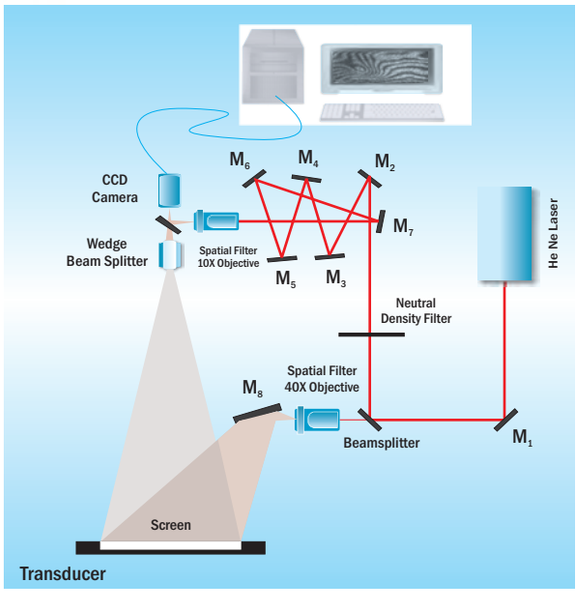
- To measure the displacement produced due to mechanical load and deformation due to temperature variations.

Features:

- Measurement under visible light is possible
- Non contact and full field measurements
- Object contour and displacement measurements

As this interferometer is highly sensitive to vibrational noises, Holmarc's ESPI comes with a Vibration isolation optical breadboard. A linearly polarized 632.8nm He-Ne laser with 5mW output power is used as the light source. A beam splitter splits the laser beam into two. The transmitted beam illuminates the test object uniformly via a spatial filter assembly while the reflected beam falls on a CCD as reference beam. The image of the illuminated test object is captured by zoom lens and CCD.

Our ESPI system allows the user to perform the Electronic Speckle Shearographic interferometry in the same system without disturbing the optical set ups and alignments. Holmarc's camera application software helps to capture and analyze the images.



SPECIFICATION

Laser	He-Ne 5mW @ 632.8nm.
Beam expander	20X microscope objective with pinhole.
Zoom lens	Nikon®
Camera	1/2.5" 5 MPC MOS Color
Software	Holmarc camera application software & image analysis software.
Optical Breadboard	1200mm x 900 mm size with vibration isolation support.

* Subject to availability

Scope of supply — Quantity

Optical Breadboard with vibration isolation support	1 no.
Spatial filter assembly(20X)	1 no.
Beam splitter with mount(50 x 50mm)	2 nos.
Mirror with mount(Dia 25 mm)	7 nos.
Test object mechanical loader	1 no.
Glass plate holder with mount	2 no.
Diffuser with mount(Material Float)	2 no.
Polarizer rotator with mount(Rotation 360°)	1 no.
Camera lens assembly with mount	1 no.
Glass plate(75 x 25mm)	1 no.
Helium neon laser(Wavelength 632.8 nm)	1 no.
Heater with control unit(Output power 200W)	1 no.
CCD Camera with mount	1 no.

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An optical device where input is natural light and output is some form of polarized light is called a polarizer. The apparatus and equipments described in this section help students to understand basics of polarization and it's effects along with the laws governing this phenomena. Experimental investigations help students to acquire practical knowledge of the fundamentals of polarization and the wave properties of light.

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Brewster's Angle Apparatus

Model No: HO-ED-P-01

Holmarc's Brewster's Angle Apparatus (Model No: HO-ED-P-01) is designed to study the Brewster's angle phenomenon and the polarization of reflected light. The essential elements of the apparatus consists of a goniometer, a laser light source capable of projecting a light beam that is linearly polarized in its plane of incidence, and a pinhole photo detector with output measurement unit for detecting and measuring the intensity of light reflected. The diode laser and polarizer rotator are mounted on an optical rail.

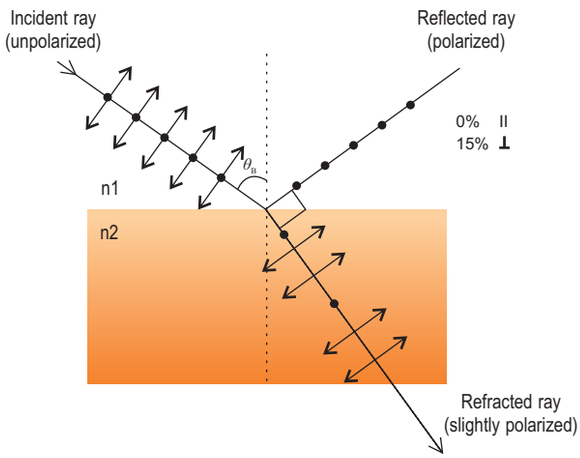
All components are made out of anodized aluminium and stainless steel for corrosion resistance.

Intensities of reflected light polarized in the plane of incidence and perpendicular to the plane are obtained as a function of angle of incidence. The results should be consistent with Fresnel's laws of reflection.

BREWSTER'S ANGLE APPARATUS - Related Topics

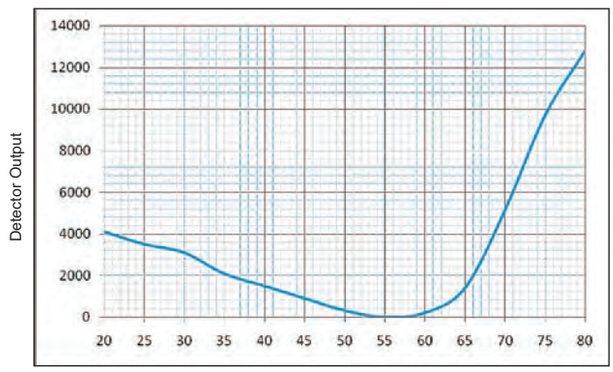
- Snell's law
- Fresnel's law of reflection
- Polarization by reflection
- Brewster's law

A beam of light incident on a di-electric transparent material can be resolved into parallel(P) and orthogonal(S) components. These components have different reflection coefficients and Brewster discovered that at a particular angle of incidence θ_B (called Brewster angle), reflection co-efficient of P- component goes zero. At this angle, direction of reflected and transmitted beam are orthogonal to each other.



Experiment Examples:

- To measure and plot the graph-reflectivity versus angle of incidence.
- To find the Brewster's angle (also known as the polarization angle) of glass plate and determination of refractive index.



Detector Output Vs Incident Angle

Scope of supply	Quantity
Goniometer with detector mount	1 no.
Optical rail (300 mm)	1 no.
Kinematic laser mount	1 no.
Polarizer rotator with mount	1 no.
Glass slide	5 nos.
Diode laser with power supply(3mW)	1 no.
Detector with output measurement unit	1 no.

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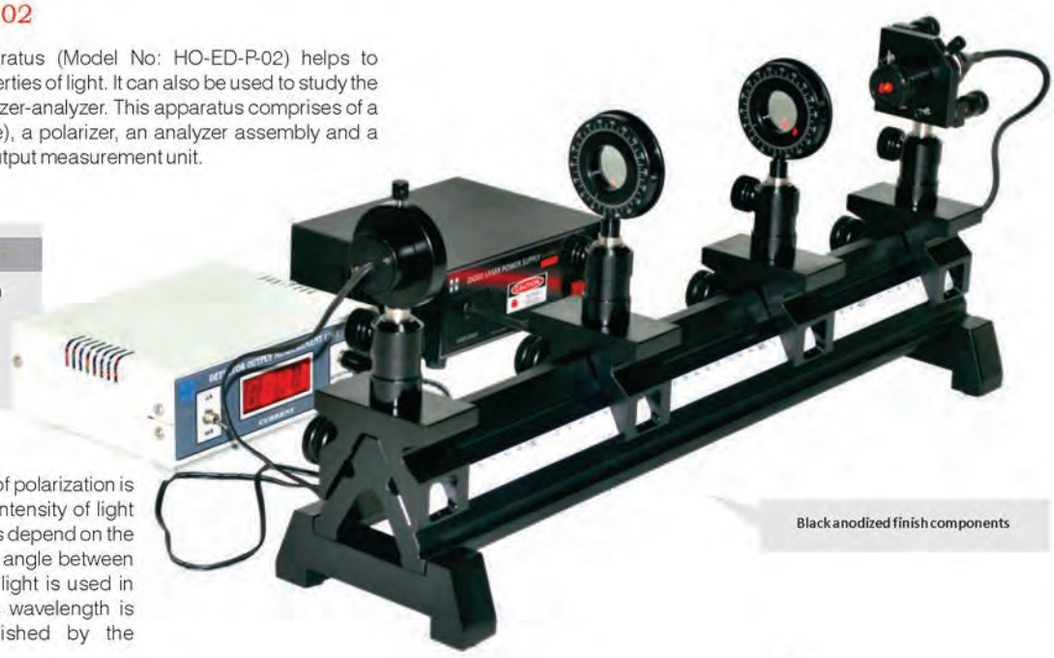
Malus Law Apparatus

Model No: HO-ED-P-02

Holmarc's Malus Law Apparatus (Model No: HO-ED-P-02) helps to understand polarization properties of light. It can also be used to study the light intensity relation of polarizer-analyzer. This apparatus comprises of a diode laser (as a light source), a polarizer, an analyzer assembly and a pinhole photo detector with output measurement unit.

MALUS LAW APPARATUS - Related Topics

- Polarization by reflection
- Malus' Law
- Polarizer
- Analyzer



Black anodized finish components

In this experiment, Malus law of polarization is verified by showing that the intensity of light passed through two polarizers depend on the square of cosine value of the angle between the two polarizer axis. Laser light is used in this experiment because it's wavelength is almost completely extinguished by the crossed polarizers.

The laser beam travelling through a polarizer is observed as a function of the orientation of the polarizer. With a second polarizer (called analyzer) the relative orientation of the polarizers is determined. The transmitted light is measured by a photo detector and the Malus Law can be verified.

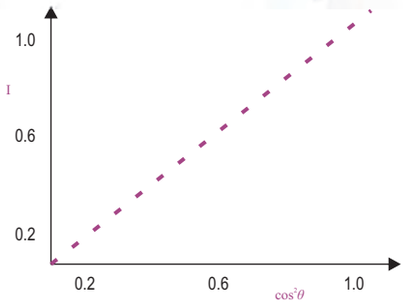


Fig. Photo detector current as a function of $\cos^2\theta$

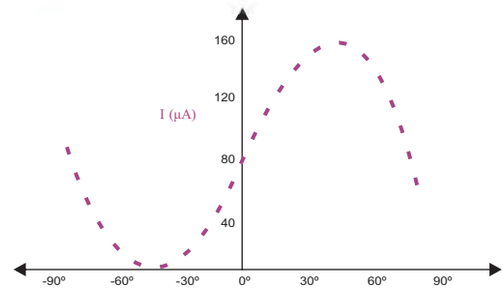


Fig. Photo detector current as a function of angular position of polarization plane of the analyzer

Experiment Examples:

- Verification of Malus law
- To measure the light intensity of plane polarized light as a function of the analyzer position
- To study the polarization properties of light

Features:

- All components are made out of anodized aluminum and stainless steel to avoid corrosion
- Holders with adjustable height and compatible in optical rail
- Graduated circular degree scale of analyzer and polarizer from 0 to 360°

Scope of supply	Quantity
Optical rail (500 mm)	1 no.
Kinematic laser mount	1 no.
Polarizer rotator with mount	2 no.
Detector mount	1 no.
Diode laser with power supply(3mW)	1 no.
Detector with output measurement unit	1 no.

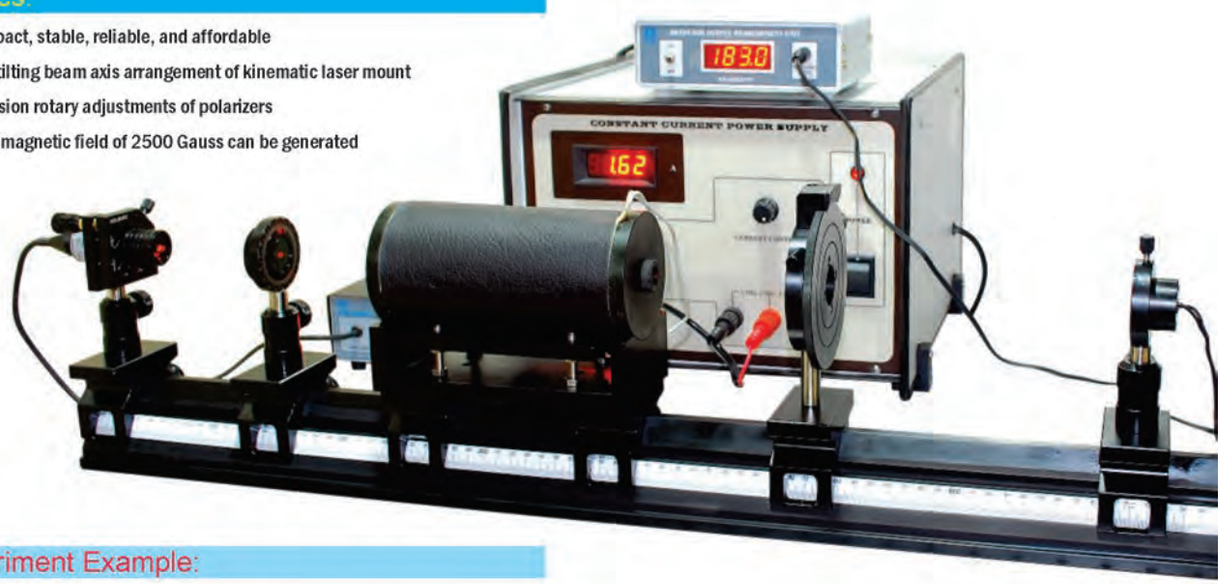
Faraday Effect Apparatus- Laser Based

Model No: HO-ED-P-04

Holmarc's Faraday Effect Apparatus (Model No: HO-ED-P-04) is designed for the determination of the Verdet constant of a material for a given wavelength of light. With its new and integrated design, this device is easier to setup and operate so that students can understand the principles and theories behind the experiment. Red and green diode lasers (λ = 650nm, 532 nm, respectively) are used for this experiment. This apparatus provides a rod of Schott N- SF57 glass as a sample. A photo detector is placed at the end of the optical rail to measure the intensity as a function of the analyzer angle θ for a full rotation. This system also consists of a power supply for the laser, a magnetic solenoid and a power supply for the solenoid.

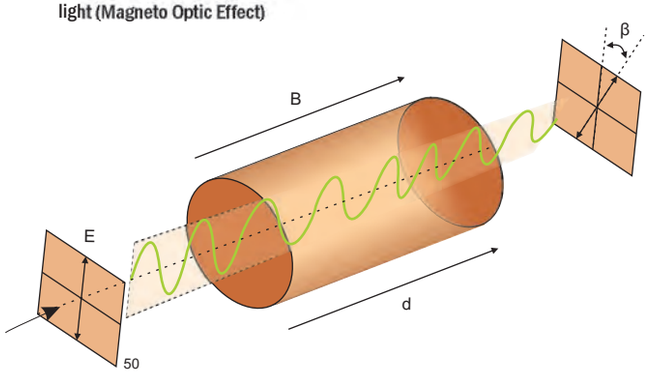
Features:

- Compact, stable, reliable, and affordable
- Fine tilting beam axis arrangement of kinematic laser mount
- Precision rotary adjustments of polarizers
- Max. magnetic field of 2500 Gauss can be generated



Experiment Example:

- Determination of the Verdet constant of the material for a given wavelength of light (Magneto Optic Effect)



Faraday Effect is a magneto optical effect in which the plane of polarized light is rotated as it passes through a medium that is placed in a magnetic field. The amount of rotation is dependent on the amount of sample through which the light passes, strength of the magnetic field and a proportionality constant called Verdet's Constant.

Optical isolators based on Faraday's effect have important applications in telecommunication. For example to prevent reflected signals on fiber optic cables from producing unwanted signals. Isolators are important when lasers are used because reflected light can cause havoc with the operation of the laser itself.

FARADAY EFFECT APPARATUS - Related Topics

- Electromagnetism
- Electromagnetic field interaction
- Polarization
- Faraday Law
- Verdet constant

Scope of supply	Quantity
Optical rail (1000 mm)	1 no.
Kinematic laser mount	1 no.
Polarizer rotator with mount	1 no.
Polarizer with precision rotation	1 no.
Detector mount with X-translation(Resolution 0.01mm)	1 no.
Electromagnet with mount	1 no.
Glass rod specimen	1 no.
Constant current power supply(230V 50 Hz)	1 no.
Diode laser with power supply (RED)5mW	1 no.
Diode laser with power supply (GREEN)5mW	1 no.
Detector with output measurement unit	1 no.

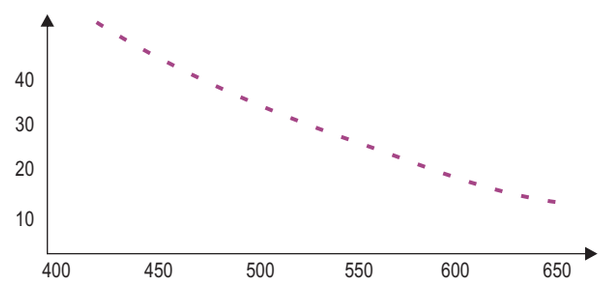


Fig. Verdet's constant as a function of wavelength

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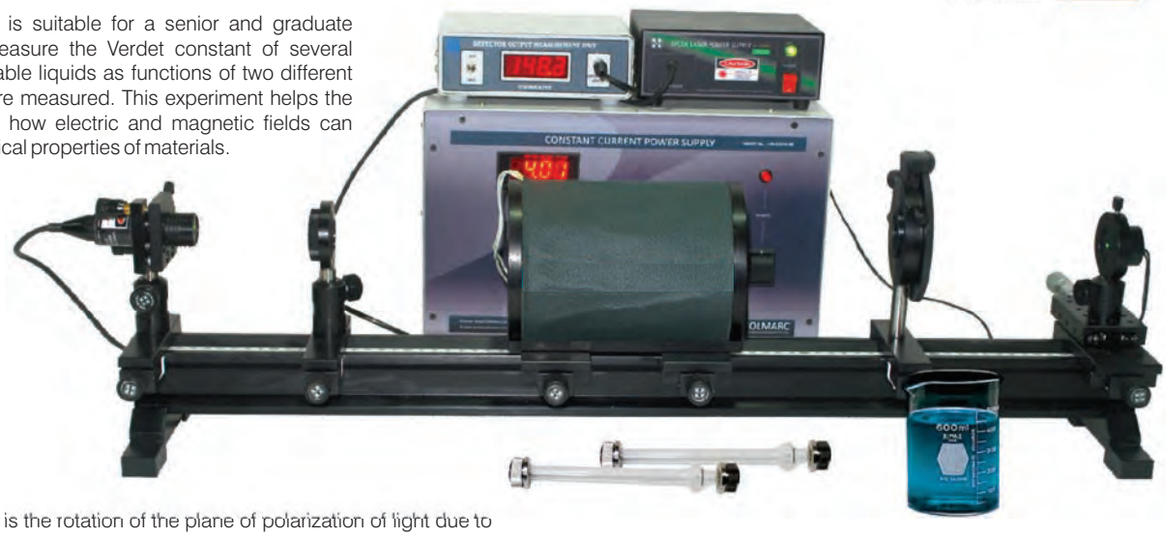
Faraday Effect Apparatus- Liquid Sample

Model No: HO-ED-P-04A

Faraday Effect Apparatus Model: HO-ED-P-04A is designed for the determination of Verdet's constant of the liquid sample at 532nm and 650nm laser light.

This experiment is suitable for a senior and graduate laboratory to measure the Verdet constant of several commonly available liquids as functions of two different wavelengths were measured. This experiment helps the student to learn how electric and magnetic fields can influence the optical properties of materials.

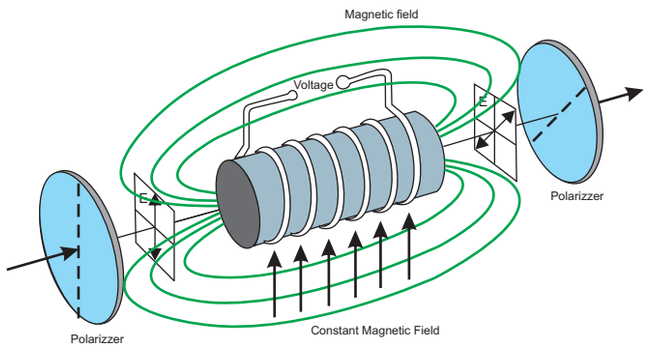
LASERS 532nm 650nm



Faraday rotation is the rotation of the plane of polarization of light due to magnetic-field-induced circular birefringence in a material. In a non-absorbing or weakly absorbing medium a linearly polarized monochromatic light beam passing through the material along the direction of the applied magnetic field experiences circular birefringence, which results in rotation of the plane of polarization of the incident light beam.

The materials used in this experiment are SF10, water, Ferric chloride solution, cinnamic acid etc. Cinnamic acid is also known as ethyl cinnamate, has a relatively high index of refraction in the visible, and also exhibits substantial dispersion.

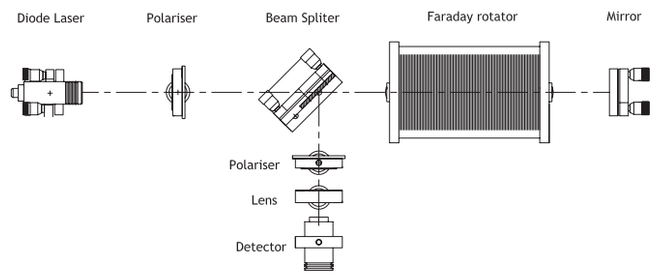
Faraday rotation measurements are taken at two different wavelengths, the green diode laser at 532nm and the red diode laser at 650nm. Laser light transmitted through a column of test liquid contained in a glass tube. The glass tube is coaxial with a solenoid coil. At the entrance end the light is plane polarized by a linear polarizer . At the exit end, the plane of polarization is determined by rotating a second polarizer called the analyzer to obtain extinction of the transmitted light. Precision polarizer rotator mount is used to take the measurement of angular rotation of the polarizer. Measure the angle of rotation for a series of coil currents.



Laser light is made to travel two times through the magneto optical element by using a beam splitter assembly, So that effective Faraday rotation will be twice as compared to the single pass. This helps to detect very small optical rotation.

HO-ED-P-04A Faraday effect electromagnet power supply has provision for direction switching. Rotation of polarization depends on the direction of the applied magnetic field, a current reversing switch on the power supply allows for easy reversal of the magnetic field.

Dual Pass Configuration(Optional)



We can setup this experiment in optical breadboard with dual pass configuration for more optical rotation

Experiment Example:

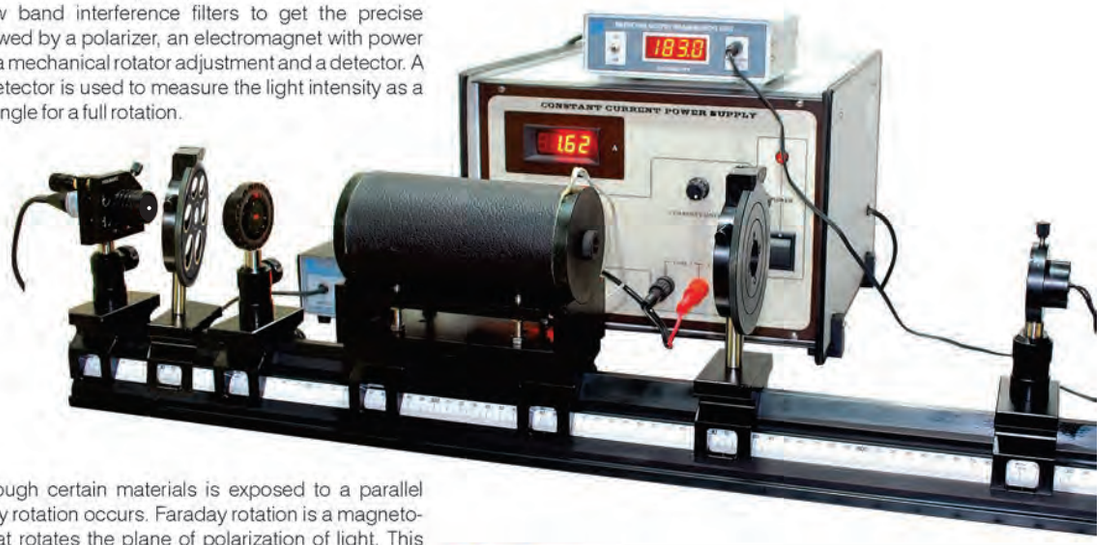
- To determine the angle of rotation of liquid samples as a function of mean magnetic flux-density using two different wavelengths of light and to calculate the corresponding Verdet's constant in each case.

NEW

Faraday Effect Apparatus - Multi wavelength

Model No: HO-ED-P-04B

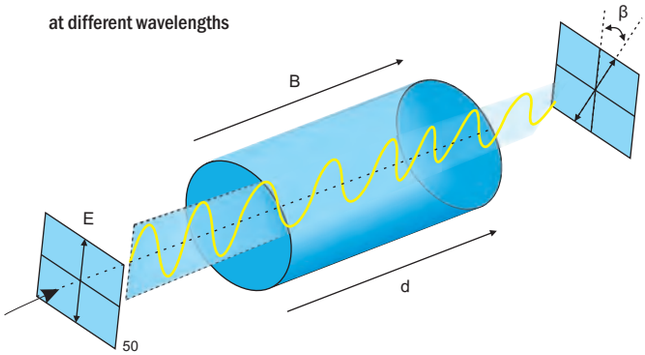
The apparatus consist of a halogen lamp as the polychromatic light source, fitted with a condenser lens system, and a filter wheel which comes with five narrow band interference filters to get the precise wavelength. This is followed by a polarizer, an electromagnet with power supply, an analyzer with a mechanical rotator adjustment and a detector. A highly sensitive photo detector is used to measure the light intensity as a function of the analyzer angle for a full rotation.



When light passing through certain materials is exposed to a parallel magnetic field, a Faraday rotation occurs. Faraday rotation is a magneto-optical phenomenon that rotates the plane of polarization of light. This experiment is appropriate for sophomore, junior, or senior students in physics. Faraday Effect Multi wavelength Apparatus can be used to measure Verdet constants in solid samples at different wavelengths.

Experiment Examples:

- To observe Faraday Effect
- To determine the angle of rotation as a function of the mean flux density at different wavelengths
- To calculate the corresponding Verdet constant of the given sample at different wavelengths



Faraday Effect is a magneto optical effect in which the plane of polarized light is rotated as it passes through a medium that is placed in a magnetic field. The amount of rotation is dependent on the amount of sample through which the light passes, strength of the magnetic field and proportionality constant called the Verdet's Constant.

$$\text{i.e } \theta = V l B$$

Strength of the magnetic field, $B = \pi N I$, where N - Number of turns per unit length of the coil, and I - current through the coil

Features

- Modern and user friendly design
- The optical filters are of high quality, in order to reduce the error while selecting the wavelength.
- Laboratory grade corrosion free components

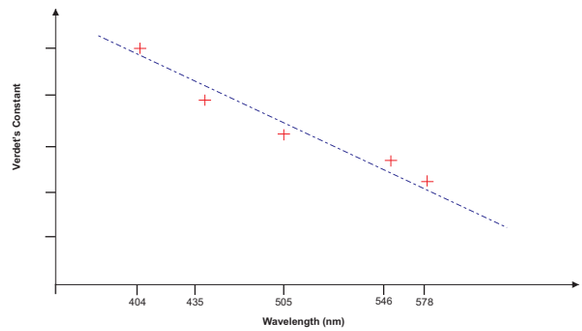


Fig. Verdet's Constant as a function of wavelength.
The '+' points represent the measured values of Verdet's Constant at different wavelengths.

Scope of supply	Quantity
Optical rail	1 no.
Halogen source with power supply	1 no.
Filter wheel with interference filters	1 no.
Polarizer rotator	1 no.
Electromagnet	1 no.
Constant current power supply	1 no.
Glass rod specimen	1 no.
Analyzer with precision adjustment	1 no.
Detector mount with stage	1 no.
Collimating lens with mount	1 no.
Detector with output measurement unit	1 no.

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Kerr Effect Apparatus

Model No: HO-ED-P-05A

Holmarc's Kerr effect apparatus (Model No: HO-ED-P-05A) is used to determine the Kerr constant of the Liquid (Nitro Benzene $C_6H_5NO_2$). In this apparatus, Nitrobenzene is used as the Kerr agent because Nitrobenzene shows a large Kerr constant than other polar liquids. Multiple travel of laser beams through Kerr cell helps to make it compact. This apparatus helps students to acquire knowledge on the fundamental physical property, Kerr Effect.

The Kerr effect, also called the quadratic electro-optic effect (QEO effect), is a change in the refractive index of a material in response to an applied electric field.

Experiment Examples:

- **To plot a graph and study the birefringence with respect to applied voltage in an electro optic liquid(Nitrobenzene $C_6H_5NO_2$)**
- **Determination of half-wave voltage of the cell**

Features:

- **Safe and convenient**
- **Rigid support for easy operation**
- **Advanced and well proven opto - mechanical designs coupled to high performance electronics**

Scope of supply	Quantity
Optical Breadboard with support(800x600 mm)	1 no.
DPSS laser mount	1 no.
Polarizer rotator with mount	2 no.
Beam splitter mount	1 no.
Kinematic mirror mount	1 no.
Plano convex lens with mount	1 no.
Detector mount	1 no.
Kerr cell mount	1 no.
Beam splitter	1 no.
Mirror with cell	1 no.
Kerr cell(Nitrobenzene)	1 no.
Switched mode power supply(0-4 KV)	1 no.
DPSS laser(5mW)	1 no.
Detector with output measurement unit	1 no

KERR EFFECT APPARATUS - Related Topics

- Quadratic electro-optic effect (Kerr effect)
- Polarization
- Half Wave Voltage
- Kerr Constant

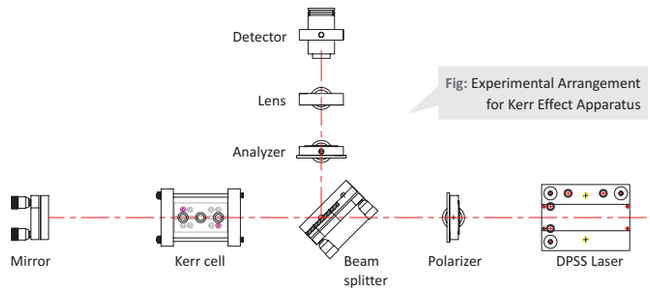

Fig: Experimental Arrangement for Kerr Effect Apparatus

In this apparatus, polarized light from a DPSS laser is directed to pass through the space between the electrodes of the Kerr cell. The beam is reflected by a mirror from the other side of the Kerr cell and again it passes through the space between the electrodes. With the help of a beamsplitter and convex lens, the beam is directed to focus on a Si photo diode detector. Embodiments of Kerr effect apparatus provide a phase-shift between the normal and the extra-ordinary light beam and it can be recorded for different voltages applied to the Kerr cell for different electric field strengths.

Kerr cell

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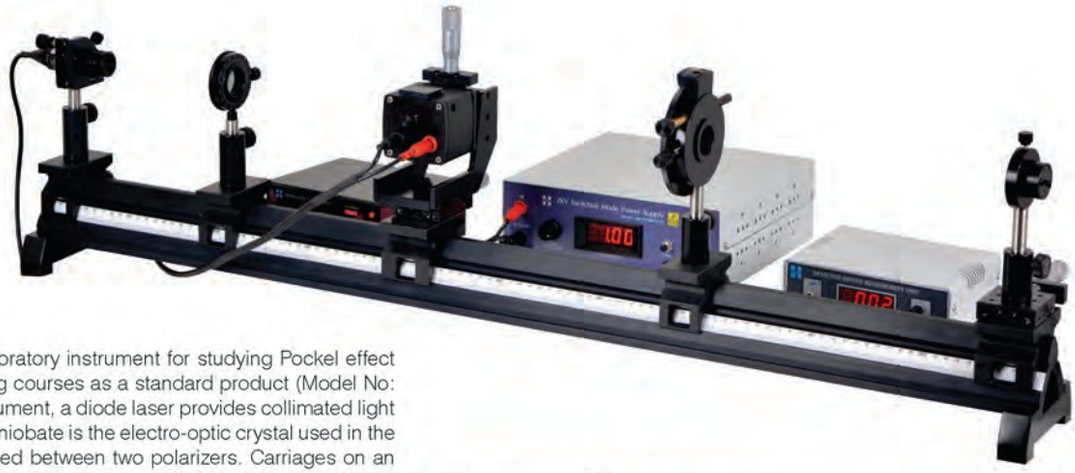
Pockel Effect Apparatus

Model No: HO-ED-P-05B

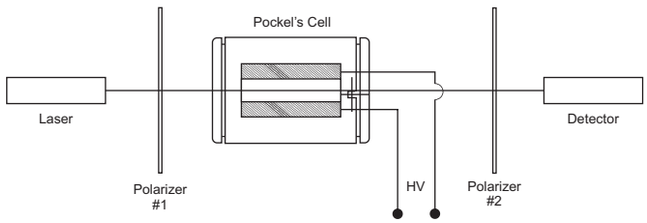
Many crystals exhibit birefringence naturally. There are certain crystals which are not birefringent naturally but become birefringent by application of an electric field. This electro-optic phenomenon is called Pockel Effect.



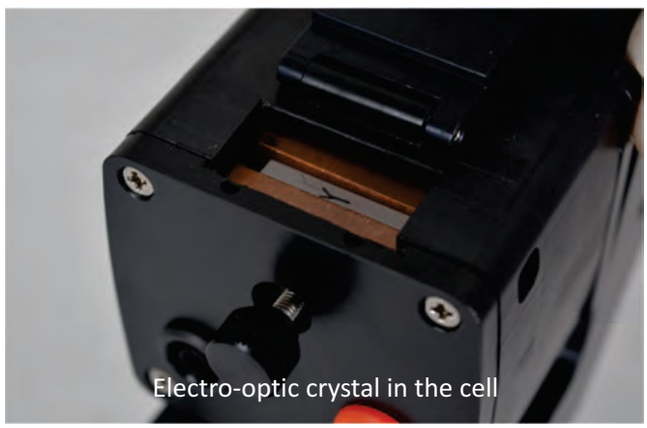
Holmarc manufactures laboratory instrument for studying Pockel effect for Physics and engineering courses as a standard product (Model No: HO-ED-P-05B). In this instrument, a diode laser provides collimated light for the experiment. Lithium niobate is the electro-optic crystal used in the Pockel cell which is arranged between two polarizers. Carriages on an optical rail hold all modules including laser and detector on a straight-line path for the experiment. The spacing between the electrodes can be varied in order to use crystals of different dimensions.

POCKEL EFFECT APPARATUS - Related Topics

- Polarization
- Birefringence
- Pockel effect
- Half Wave Voltage

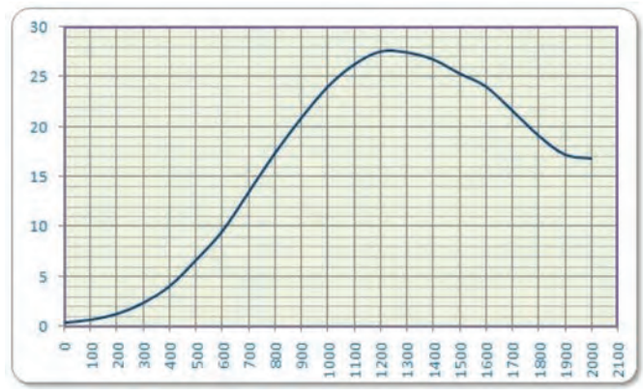


The power supply module of the instrument can apply voltages up to 2 KV across the crystal. Experiment can be done by varying the applied voltage and recording the detector output reading at various voltage levels. The birefringence is increasing function of the applied voltage, so, transmission will be an oscillatory function of the applied voltage.


Electro-optic crystal in the cell

Experiment Example:

- To plot the graph and study the birefringence with respect to applied voltage in an electro optic crystal (Lithium niobate)



Intensity Vs Applied voltage

Features:

- Enhanced and integrated design with drive voltage 0-2 KV
- Precise measurements
- Clear process observation and can study electro-optic effect
- High sensitivity pin hole photo detector

Scope of supply	Quantity
Optical rail (1000 mm)	1 no.
Kinematic laser mount	1 no.
Polarizer rotator with mount	1 no.
Polarizer with precision rotation	1 no.
Detector mount with X-translation	1 no.
Pockel cell with mount	1 no.
Electro-optic crystal (Lithium Niobate)	1 no.
Switched mode power supply(0-2 KV)	1 no.
Diode laser with power supply (3 mW)	1 no.
Detector with output measurement	1 no.

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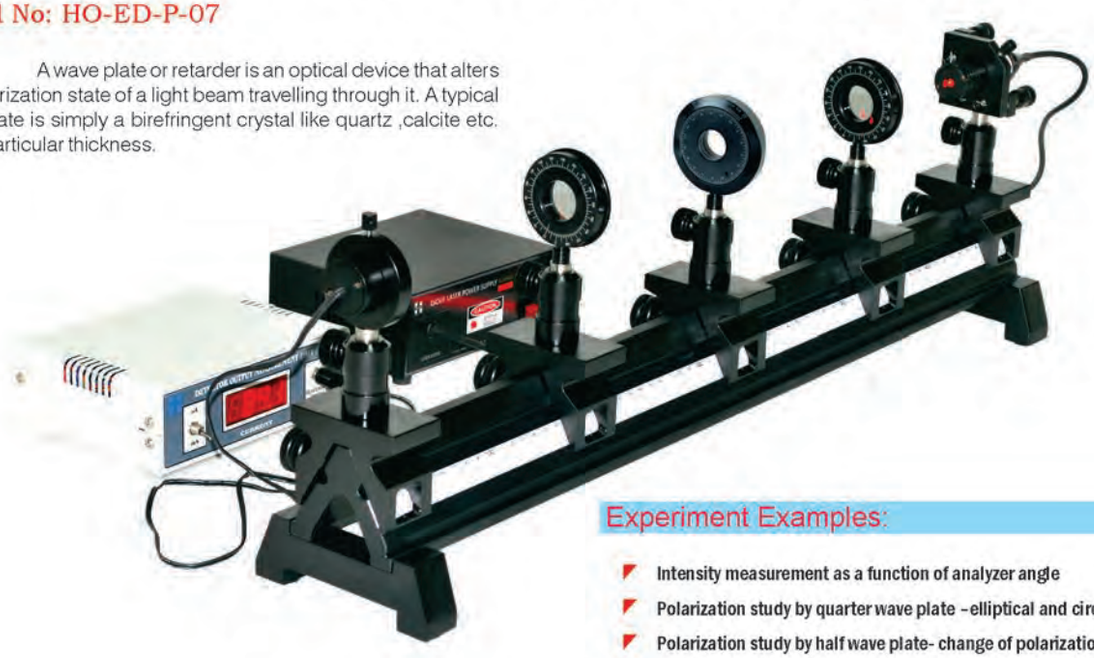
Apparatus for the Study of Polarisation by Waveplates

Model No: HO-ED-P-07

A wave plate or retarder is an optical device that alters the polarization state of a light beam travelling through it. A typical wave plate is simply a birefringent crystal like quartz ,calcite etc. with a particular thickness.



If a beam of parallel light passes perpendicularly through a wave plate, the light beam is split into two components due to its double refracting properties. The two components have planes of oscillation perpendicular to each other and slightly different phase velocities. For a quarter-wave plate, the thickness of the quartz plate is chosen in such a manner that the light component whose electric field vector oscillates parallel to the rotation lever lags by a λ/4 behind other perpendicular oscillating light component. For a half-wave plate the thickness is chosen so that the created phase difference is λ/2.

Features:

- Anodized finish for aluminium
- Compact and user friendly design

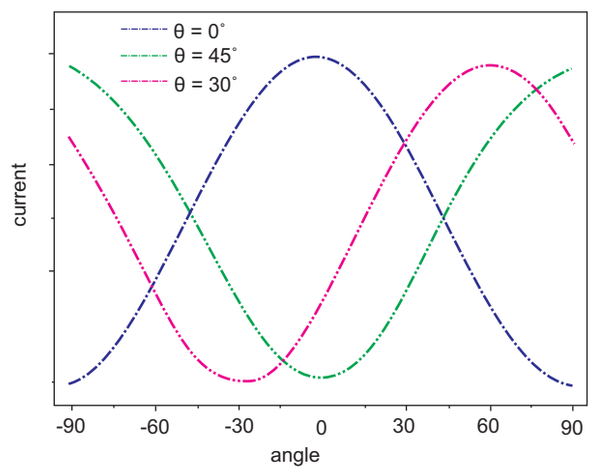


Fig: Current as a function of the analyzer position for various half wave plate positions

Experiment Examples:

- Intensity measurement as a function of analyzer angle
- Polarization study by quarter wave plate –elliptical and circular polarization.
- Polarization study by half wave plate- change of polarization axis.
- Verification of Malus' law

In this experiment a laser beam passes through a polarizer, quarter-wave or half-wave plate, analyzer and finally falls on the detector. The polarization of the emergent light is investigated at different angles between the optic axis of the wave plates and the direction of the incident light. The detector output current is recorded at different analyzer angles. The change of polarization state and axis can be studied from the graph between detector output current and analyzer angle.

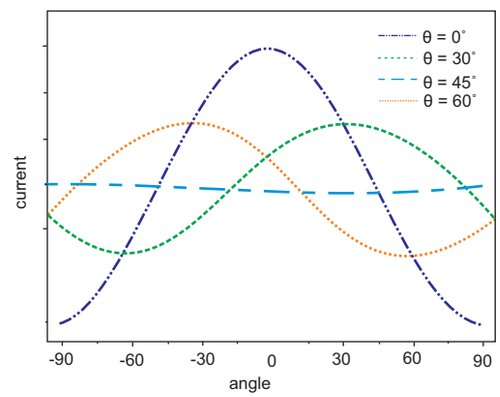


Fig: Current as a function of the analyzer position for various quarter wave plate positions

Scope of supply	Quantity
Diode laser with power supply	1 no.
Polarizer rotator with mount	1 no.
Analyser rotator with mount	1 no.
Wave plate rotator with mount	1 no.
Half wave & quarter wave plates	1 no each.
Detector with output measurement unit	1 no.

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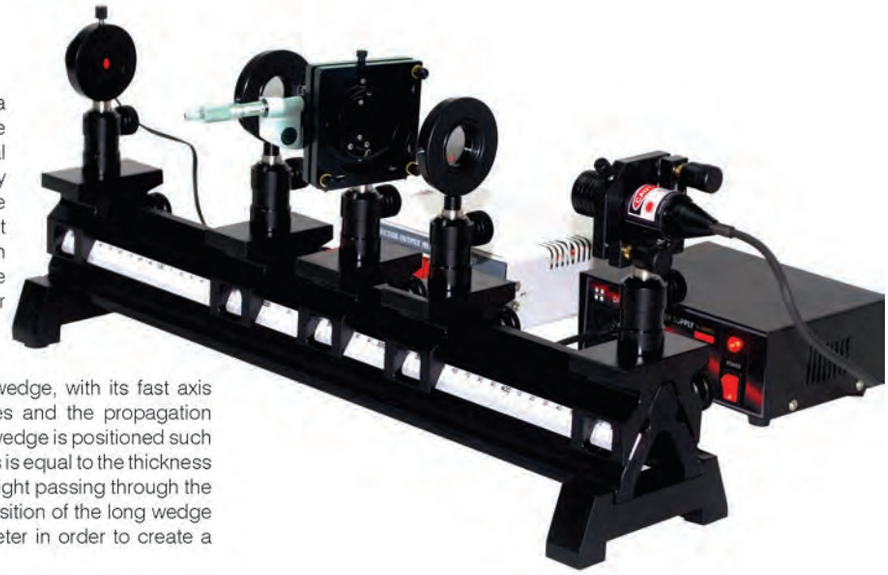
Babinet Compensator

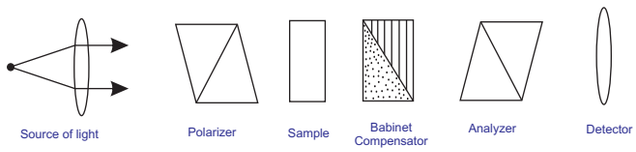
Model No: HO-ED-P-08



A Soleil-Babinet Compensator is a continuously variable zero-order retarder (wave plate) that can be used over a broad spectral range.The variable retardance is achieved by adjusting the position of a long birefringent wedge with respect to a short fixed birefringent wedge.The wedge angle and fast axis orientation is the same for both wedges so that the retardance is uniform across the entire clear aperture of the Soleil-Babinet compensator.

A compensator plate is attached to the fixed wedge, with its fast axis orthogonal to both the fast axis of the wedges and the propagation direction of the light. When the long birefringent wedge is positioned such that the total thickness of the two stacked wedges is equal to the thickness of the compensator plate, the net retardance of light passing through the Soleil-Babinet compensator will be zero. The position of the long wedge can then be adjusted with a precision micrometer in order to create a retardance transmitted beam of light.

calibration of the Babinet compensator with monochromatic light



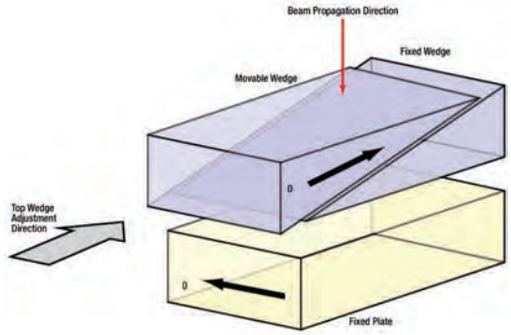
A schematic diagram of the experimental setup

Experiment procedure:

Determine precisely the Babinet compensator interfringe at the wavelength of the green line of mercury. This is about 2.4 mm. The polarizers are spaced apart with their polarization axis rotated 90° to each other so that no light is transmitted. At this point the polarizers are crossed. Insert compensator in between the two polarizers. Adjust the tip/tilt so that the compensator is perpendicular to the optical beam. Turn the Babinet compensator to find the extinction. Fringes of high contrast should appear. Using micrometer, record the reading between two null position of the fringe.

SPECIFICATION

Wavelength range	380- 650 nm
Retardation range	2π radiance
Aperture	10mm
Rotation	360°



Measurement of the sample birefringence

Using Babinet compensator, ordinary and extra-ordinary rays of light are produced. These light rays interfere and the interference fringes are observed. By introducing the sample sheet in between the incident ray and Babinet compensator, shift in the fringe pattern is produced. The fringe shift is measured and the differences in the refractive indices of the ordinary and extraordinary rays are calculated.

BABINET COMPENSATOR - Related Topics

- Wavelength
- Polarization
- Babinet compensator
- Birefringence

Experiment Examples:

- To calibrate the Babinet compensator with monochromatic light.
- Measurement of the sample birefringence.

Scope of supply	Quantity
Optical rail(500mm)	1 no.
Babinet compensator with mount	1 no.
Polarizer with mount	1 no.
Analyzer with mount	1 no.
Diode laser with power supply	1 no.
Detector with output measurement unit	1 no.
Sample with mount	1 no.

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The objective of our fiber optics based experiments is to impart basic knowledge in principles and applications of fiber optics. It includes a number of laboratory exercises aimed to give hands on experience in basic concepts.

The experiments help to acquire knowledge on laboratory techniques which can be used for the characterization of important fibre parameters.

Optical Fiber Characterization Apparatus (Rail Based) 32
Model No: HO-ED-F-02

Optical Fiber Characterization Apparatus (Breadboard Based) 33
Model No: HO-ED-F-03

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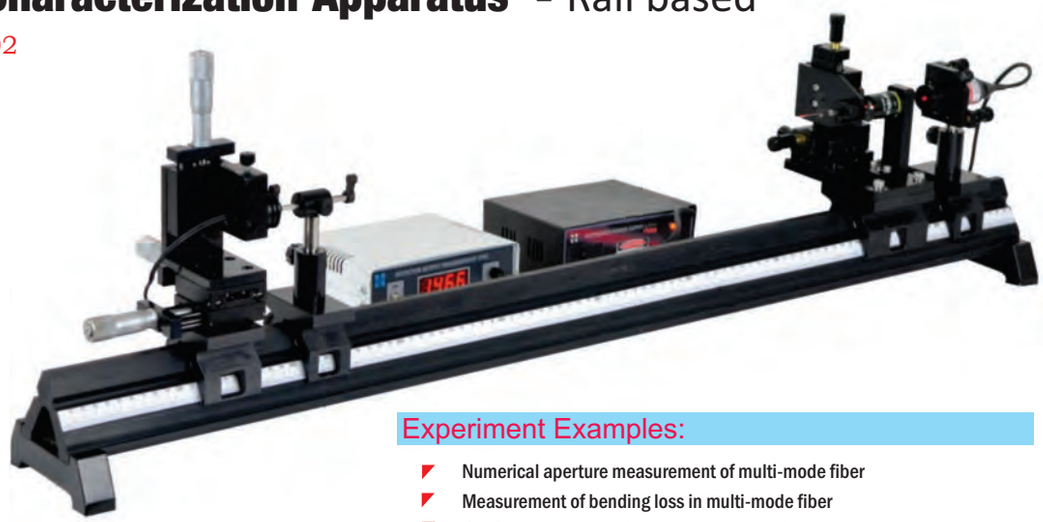
Optical Fiber Characterization Apparatus - Rail based

Model No: HO-ED-F-02



In this apparatus, both single mode and multi-mode fibers are used for the experiments. The apparatus makes use of rail and carriage system for mounting and adjusting the optical components required for experiments. Diode laser is used as light source. Laser fiber coupler is used to couple light from laser to fiber input end efficiently. There are mounts to hold input and output ends of the fiber firmly. Detector is placed on an XYZ stage. Distance between each component can be adjusted using the rail and carriage mechanism.

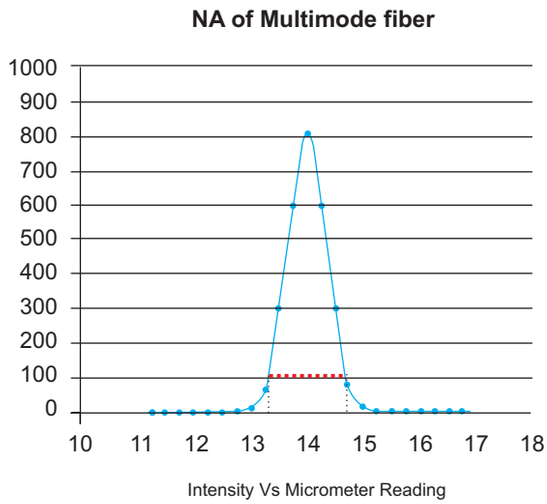
Features:

- Single mode and multi-mode fibers
- Diode laser is used as light source
- High precision Laser coupler
- Highly sensitive photo detector

The experiment helps students to understand concepts of numerical aperture, bending loss, splice loss etc. The laser light is coupled to optical fiber with the use of an objective lens for maximum coupling efficiency. Numerical aperture is found out by scanning the far field of the optical fiber using a photo detector mounted on a translation stage. Corrosion resistant materials like stainless steel and aluminium alloys are used for the construction of all components used in this apparatus.

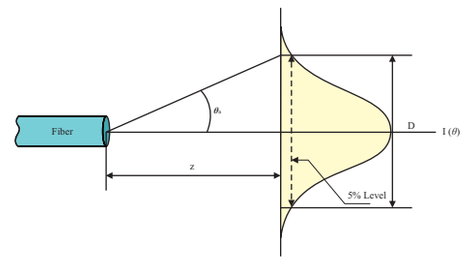
OPTICAL FIBER CHARACTERIZATION- Related Topics

- Total internal reflection
- Splice loss
- Numerical aperture of fiber
- Single mode and Multi mode fiber



Experiment Examples:

- Numerical aperture measurement of multi-mode fiber
- Measurement of bending loss in multi-mode fiber
- Relative measurement of splice loss in multi-mode fiber
- Numerical aperture measurement of single mode fiber
- Calculation of normalized frequency or V-number of single mode fiber
- Calculation of mode field diameter of single mode fiber.



Scope of supply	Quantity
Optical rail(Length 1000mm)	1 no.
Kinematic laser mount	1 no.
Detector mount	1 no.
XYZ translation stage with mount (Micrometer controlled)	1 no.
Laser fiber coupler with mount(Magnification 10X)	1 no.
Fiber holder with angular tilt(Resolution 2°)	1 no.
Fiber chuck holder	1 no.
Bending loss apparatus(Step diameter 35,45,55,65mm)	1 no.
Fiber chuck (Diameter 30mm)	1 no.
Single mode optical fiber (Numerical Aperture 0.11)	1 no.
Multi-mode optical fiber(250 & 750 micron)	1 no each.
Diode laser with power supply (Red) (Wave length 650nm)	1 no.
Detector with output measurement unit	1 no.

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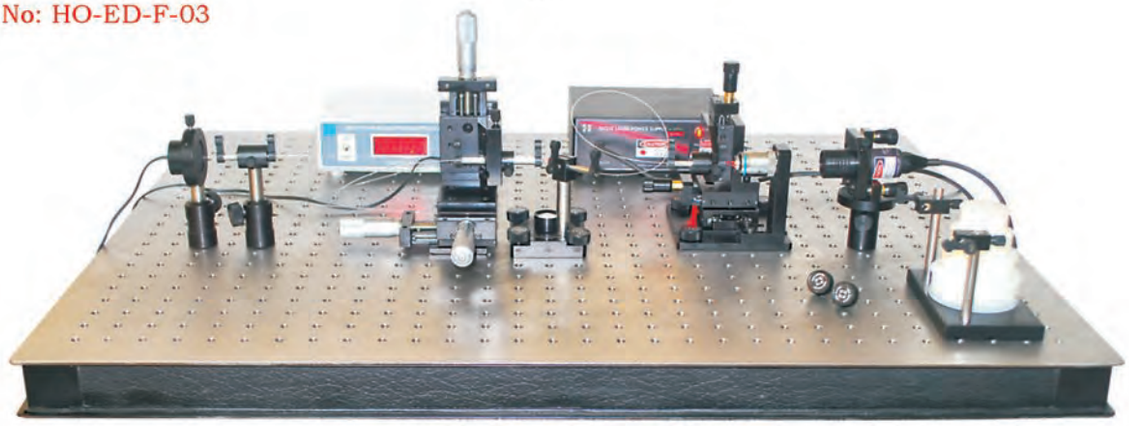
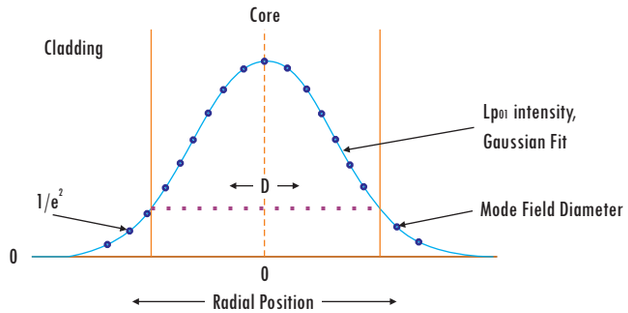
Optical Fiber Characterization Apparatus - Breadboard Based

Model No: HO-ED-F-03



In the model HO-ED-F-03, components are mounted on an optical breadboard (800 x 600mm) for performing the experiment. The use of optical breadboard makes the system flexible and helps to setup the experiments easily. In this model, various components can be arranged on the breadboard with desired configurations. There are M6 tap holes at 25mm grid throughout the breadboard to facilitate mounting.

The experiment helps students to understand concepts of numerical aperture, bending loss, splice loss, total internal reflection etc. The laser light is coupled to optical fiber by the use of an objective lens for maximum coupling efficiency. Numerical aperture is found out by scanning the far field of the optical fiber using a photo detector mounted on a translation stage



Scope of supply — Quantity

Optical Breadboard with support	1 no.
Kinematic laser mount	1 no.
Detector mount	1 no.
XYZ translation stage(Resolution 0.01mm)	1 no.
Laser fiber coupler(Magnification of objective 10X)	1 no.
Fiber holder with angular tilt(Resolution 2°)	1 no.
Fiber chuck holder	1 no.
PMMA mount	1 no.
Bending loss apparatus(Step diameter 35,45,55,65mm)	1 no.
Fiber chuck	1 no.
PMMA rod(Size 150 x 25 x 25 mm)	1 no.
Single mode optical fiber(Numerical aperture 0.11)	1 no.
Multi mode optical fiber)	1 no.
Diode laser with power supply(Wave length 650nm)	1 no.
Detector with output measurement unit	1 no.

Experiment Examples:

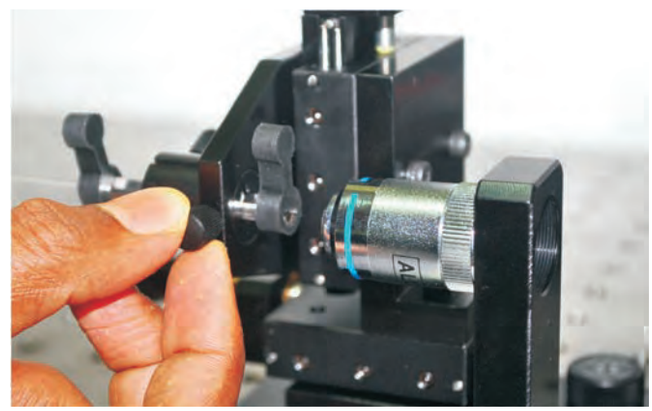
- Numerical aperture measurement of multi-mode fiber
- Measurement of bending loss in multi-mode fiber
- Relative measurement of splice loss in multi-mode fiber
- Numerical aperture measurement of single mode fiber
- Calculation of normalized frequency or V-number of single mode fiber
- Calculation of mode field diameter of single mode fiber
- Determination of refractive index of transparent solids

Features:

- Easy and flexible
- Experiments based on both single mode and multi-mode fibers
- Diode laser is used as light source
- High precision laser coupler
- Photo transistor type photo detector
- Rigid base
- Corrosion free components

OPTICAL FIBER CHARACTERIZATION- Related Topics

- Total internal reflection
- Splice loss
- Numerical aperture of fiber
- Single mode and multi mode fiber



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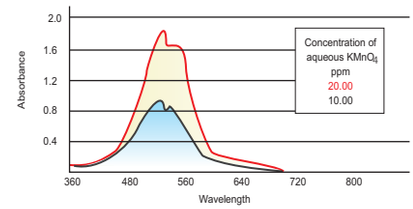
HOLMARC's BioLAB series UV-Vis spectrophotometer is a high-performance, reliable, and exceptional value instrument. Unlike other entry level spectrophotometers, it employs classic Czerny - Turner monochromator design, normally available only with advanced models, which ensures low stray light. Micro-stepping drive simplifies mechanical complexity, reduces maintenance and improves the longevity. 1200 lines/mm blazed holographic grating is used as the dispersion element providing high wavelength resolution. It also employs a sigma delta ADC of 16 bit resolution for photometric measurements, which is higher than that of most of the spectrophotometers available in this price range. Large LCD and friendly interface make the operation extremely easy. It can be used to plot an absorbance v/s wavelength graph. The data can then be analyzed for peaks and valleys. These models also feature PC control functions based on Spectra PhotoANALYTE software. The system allows users photometric measurement, spectrum scanning, quantitative determination, kinetic measurement, data processing etc.

Photometric mode measures the absorbance or transmittance at a single wavelength or at multiple wavelengths. Spectrum mode obtains sample spectra using wavelength scanning. Changes in the sample can be tracked through repeated scans. Quantitation mode generates a calibration curve from standard samples and uses it to calculate concentrations of unknown samples. Kinetics mode measures the change in absorbance as a function of time, and thereby obtains enzymatic activity values. Time scan mode measures the change in absorbance, transmittance and energy as a function of time.

Spectra PhotoANALYTE

Powerful Software designed for Photometry

- Spectrum scanning
- Photometric measurements
- Kinetic measurements
- Quantitative determination
- Multi component analysis
- Powerful data processing abilities



Model	BioLAB UV 500	BioLAB VIS 300
Bandwidth	2nm	2nm
Optical system	C-T monochromator, 1200 l/mm holographic grating	
Wavelength range	190 ~1100nm	350 ~1100nm
Photometric method	Transmittance, Absorbance, Concentration	
Wavelength accuracy	±0.8nm	
Wavelength repeatability	±0.2nm	
Absorbance range	-3 ~ 3Abs	
Photometric accuracy	±0.002A (0 ~ 0.5A), ±0.004A (0.5 ~ 1A), ±0.3% T	
Photometric repeatability	≤0.001A (0 ~ 0.5A), ≤0.002A (0.5 ~ 1A), ±0.1% T	
Stray light	≤0.05% T	
Baseline straightness	±0.002A	
Detector	Si-Photodiode	
Light source	Xenon flash lamp	Quartz halogen lamp
Cell holder	Two-position 10mm standard cuvette holder	
Display	320 × 240 pixel graphic LCD	
Control mode	Stand alone or PC control	
Dimensions (LxWxH) mm	320x248x130	310x235x108

Scanning features any range between 190 and 1100nm * UV-500 (350-1100nm for VIS-300 model)
Selectable scan wavelength interval of 1 to 50nm
Live absorbance plot during scanning
Plot browser to read absorbance values at each wavelength
Analyzer to find out absorbance and wavelength of peaks and valleys

Glass, quartz cuvettes and Holders

Custom Glass Cuvettes

We manufacture quartz cells and cuvettes of custom specifications for spectrometer, spectrophotometer, colorimeter and other instruments.

cuvette holder

Cuvette holder unit is manufactured for various cuvette sizes and applications. Some cuvette holders are equipped with SMA fiber connectors and collimators.

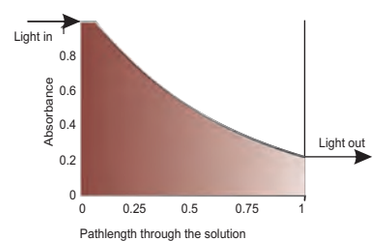


Fig. Light Absorbed through a Solution

Lasers and Opto-electronics play an ever growing role in all walks of modern life, be it in communication, entertainment, manufacturing or instrumentation. Holmarc's products in opto-electronics are designed to introduce the basics of opto-electronic devices and its characteristics. Our laser optics lab (Model No: HO-ED-LOL-01) can be used for research projects in related disciplines as well.

Apparatus for Characteristic Study of Diode Laser 35
Model No: HO-ED-LOE- 01

Apparatus for Laser Beam Profile Analysis 36
Model No: HO-ED-LOE- 01A

Apparatus for Opto-Electronics Characterization 37
Model No: HO- ED-LOE- 02

Z-Scan System 38
Model No: HO- ED-LOE- 03

Apparatus for Opto-Electronics Spectroscopic 39
Characterization (Spectral Characterization of LED)
Model No: HO- ED-LOE- 04

Determination of Conversion Efficiency of Crystals – 40
Second Harmonic Generation
Model No: HO-ED-LOE-05

Laser Optics Lab 41
Model No: HO-ED- LOL- 01

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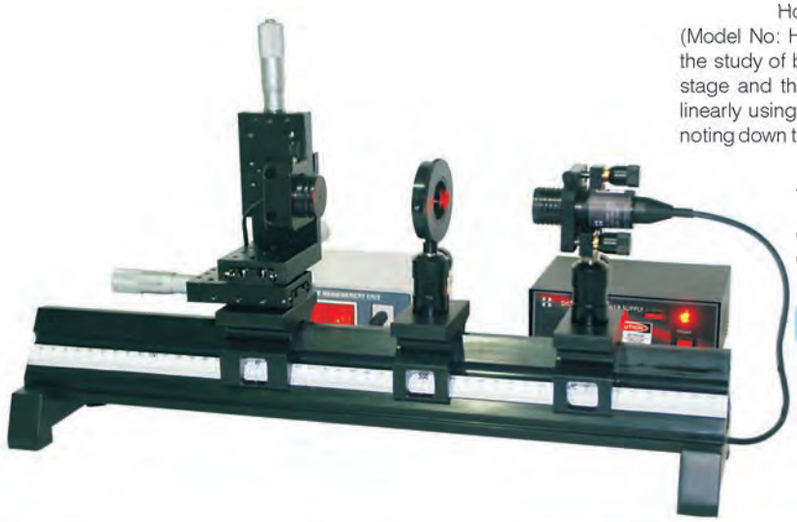
Apparatus for Characteristic study of Diode Laser

Model No: HO-ED-LOE-01



Holmarc's Apparatus for Characteristic Study of Diode Laser (Model No: HO-ED-LOE-01) is an important educational instrument for the study of beam profile with the detector mounted on XYZ translation stage and the diode laser. In this apparatus, the detector is scanned linearly using a translation stage along the cross section of laser beam noting down the intensity readings at close intervals.

A graph is plotted from the readings for finding out attributes like Gaussian nature, divergence etc. The laser diode is designed to produce a cone of divergent radiation with an elliptical cross-section and Gaussian intensity distribution.

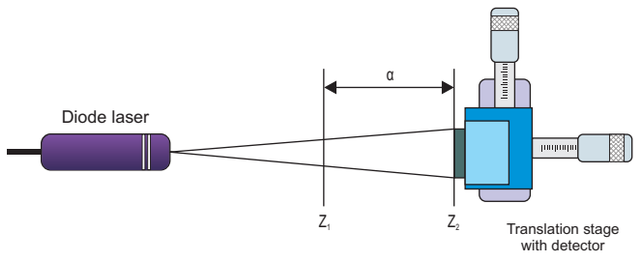
Experiment Examples:

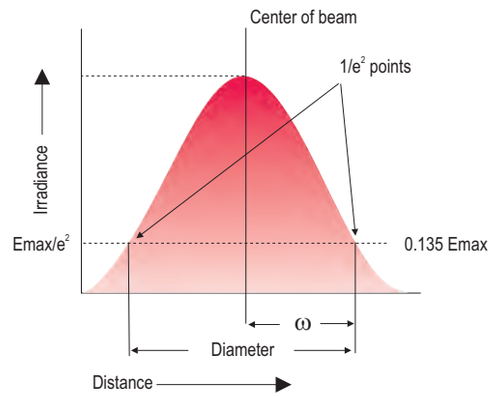
- To study gaussian nature of the laser beam.
- To find diameter (beam spot size) of the laser beam.
- To determine divergence of the laser beam.
- To study polarization nature of the laser beam.

CHARACTERISTIC STUDY OF DIODE LASER - Related Topics

- Gaussian nature
- Polarization nature
- Beam spot size
- Laser beam divergence

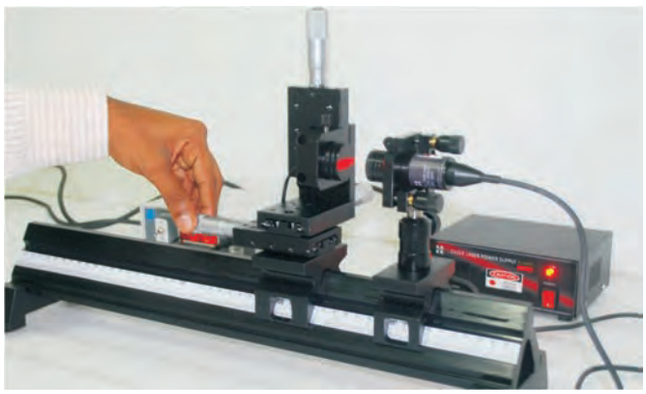
For studying polarization nature of the laser beam, diverging laser output is made to pass through a polarizer which is fixed on a rotary mount with graduations. Using the detector and readout, intensity at various rotary positions of the polarizer is tabulated. The degree of polarization varies with the diode current.





TECHNICAL SPECIFICATION OF LASER

Laser type	Diode laser (Red)
Input	230V AC / 50 Hz
Output power	3mW
Wavelength	650nm



Features:

- Laser assures smooth switch on and long life.
- Light sensor range 0-199 milli / micro amperes
- Linear travel of 25mm for XYZ axis
- Precision micrometer driven translation stage with resolution of 10 microns

Scope of supply	Quantity
Optical rail (Length 500 mm)	1 no.
Kinematic laser mount	1 no.
Polarizer rotator with mount	1 no.
XYZ translation stage with mount(Resolution 0.01 mm)	1 no.
Diode laser with power supply(3mW/650nm)	1 no.
Detector with output measurement unit	1 no.

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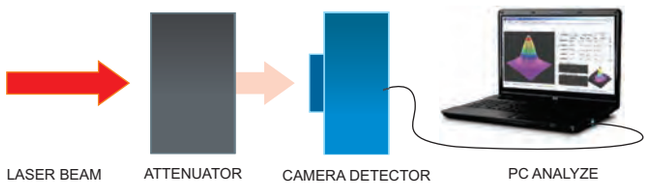
Apparatus for Laser Beam profile Analysis

Model No: HO-ED-LOE-01A

The Laser beam profiler is a high precision, CCD based (for VIS/NIR)device to be used with lasers having wavelengths between 340nm and 1100 nm. Coupled with software package, the device can be used for quick and accurate characterization of lasers.

A laser beam profile is produced to identify spatial characteristics that predict the propagation, quality, and utility of a laser beam. These spatial characteristics include beam width, divergence and direction. Laser beam profiling is important for manufacturers of products that utilize lasers as the core technology.

Applications in medical and industrial fields often require laser source as tools, and these lasers must be analyzed and well understood. Products designed for laser printing, welding, cutting and fiber optics require information about the efficiency, power, special distribution and uniformity of the beam, possible only through laser beam profiling systems.



Measurement of Laser Beam Profile and Propagation Characteristics

Features:

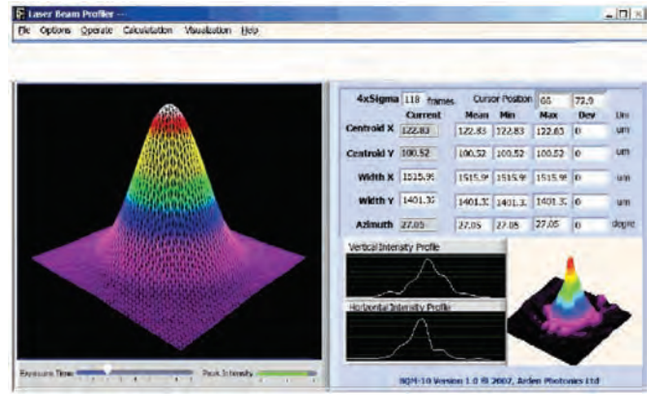
- Laser beam and wavefront profiling
- Beam propagation analysis
- Beam shaping and beam monitoring

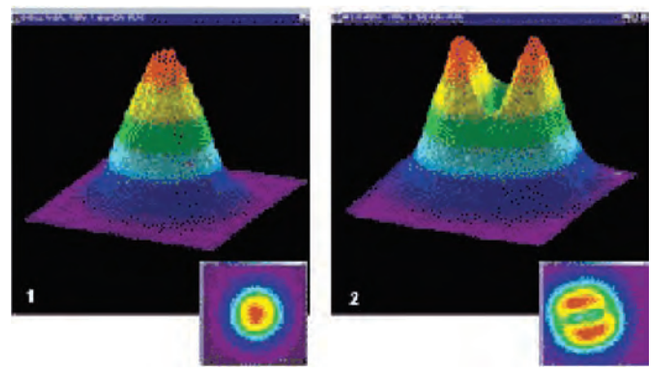
HOLMARC IMAGE ANALYZER PRO

Two major electronic techniques are used to image laser beams, mechanical scanning devices and camera based systems. Mechanical scanning devices employ moving pinholes to attenuate the beam as well as to sample it, while camera-based systems image the beam that reaches the array. Mechanical scanning system assemble a beam image after making multiple passes through the beam. This limits the number of images that can be displayed and generally not considered to work in real time. Further, they are not suitable for pulsed lasers.

Camera-based systems image the beam at the frame rate of the camera. The images produced enable the user to view short-term transient effects of the laser. This experiment setup concentrate on camera based systems as it is generally acknowledged that they can yield more detailed, real-time profile information.

Holmarc Laser Beam Profiler (LBP) enables quick and accurate measurement of laser beams as well as other spot light sources. There are two models, one for educational application (Model : HO-ED-LOE-01A) which is based on CMOS sensor and the other is intended for scientific application based on CCD camera Model : HO-ED-LOE-01B. Both these laser beam profiler models include HOLMARC IMAGE Analysis Software.





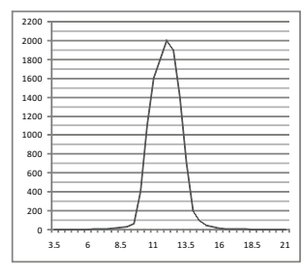


Fig. Intensity measurement as function of pixel. The software developed for laser beam profiler (LBP) can generate line and average plot of intensities from the image.

Experiment Examples:

- To study the polarization nature of laser beam and find the polarization extinction ratio of the laser beam.
- To measure the divergence of the laser beam.
- To measure the divergence of laser beam using a lens of known focal length.
- To study the Gaussian nature of laser beam.
- To measure the diameter (beam spot size) of the laser beam.

Apparatus for Opto - Electronics Characterization

Model No: HO-ED-LOE-02

Holmarc's Apparatus Model HO-ED-LOE-02 is for the characterization of Opto-electronic components. Opto-electronics is the study and application of electronic devices that interacts with light. Opto-electronic devices are electrical to optical / optical to electrical transducers or instruments. These introductory- level experiments reveal the basic concepts of opto-electronics and are useful in courses dealing with applied physics, fiber optics, electronic devices, etc.

Experiment Examples:

- Characteristic study of Light Dependent Resistor (LDR)
- Characteristic study of Light Emitting Diode (LED)
- Characteristic study of Photo Transistor
- Characteristic study of Photo Diode
- Characteristic study of Solar Cell
- Characteristic study of Opto-Coupler

Opto-electronics is based on the quantum mechanical effects of light on electronic materials, especially semiconductors, sometimes in the presence of electric fields.

The apparatus consists of a diode laser and cell mount to which any of the opto - electronic components can be attached easily. Opto electronic components are fixed inside metallic casing for ease of mounting in an experimental setup. The terminals of the components are taken out through a cable which has a pair of stereo connector . Both source and the detector are placed on the optical rail using carriage system. Linearly variable light intensity is obtained by using polarizer with a rotary mount in front of the laser.

Photoelectric or photovoltaic effect, used in:

- photo diodes
- solar cells
- photo transistors

Lossev effect or radiative recombination, used in:

- light-emitting diodes or LED

Photo conductivity , used in:

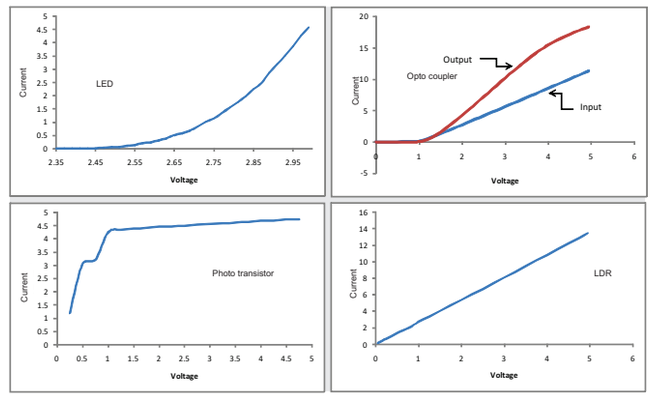
- Light Dependent Resistor (LDR)

Optical isolation , used in:

- Opto - coupler

APPARATUS FOR OPTO - ELECTRONICS CHARACTERIZATION - Related Topics

Photo transistor | Opto-coupler | LED | LDR | Solar cell | Opto-electronics | Photo diode



V-I Characteristics

Scope of supply	Quantity
Optical rail (length 500mm)	1 no.
Kinematic laser mount	1 no.
Polarizer rotator with mount (Resolution 1°)	1 no.
Detector mount	1 no.
Mounted opto - electronic detectors	7 nos.
Opto - electronic measurement unit (230V AC / 50Hz)	1 no.
Diode laser with power supply (650nm,3mW)	1 no.

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Z-Scan system

Model No: HO-ED-LOE-03

The Z-Scan technique is a simple and popular experimental technique used to measure intensity dependent nonlinear susceptibi ities of materials.

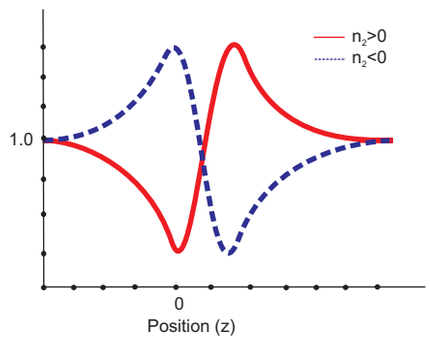
Z-SCAN SYSTEM - Related Topics

- Non linear absorption
- Non linear refraction
- Non linear susceptibility

Holmarc's Z-Scan System (Model No: HO-ED-LOE-03) is a simple implementation of the z-scan technique that can be used to characterize optical materials.

Features:

- Characterize non-linear properties of optical materials
- Photo detector with spectral response range of 320 -1100nm
- User- friendly software
- Highly precision optics
- Mechanical components with black anodized finish
- Optical breadboard make the system flexible

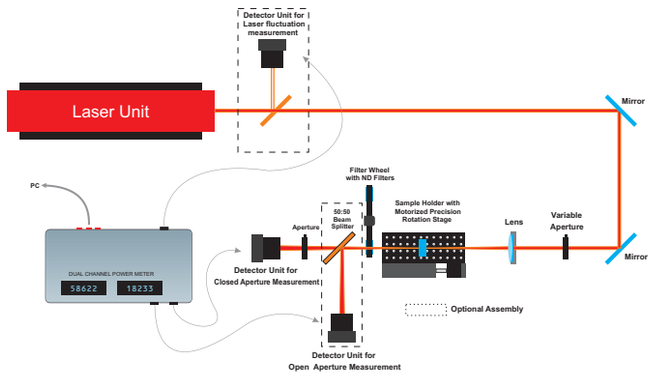


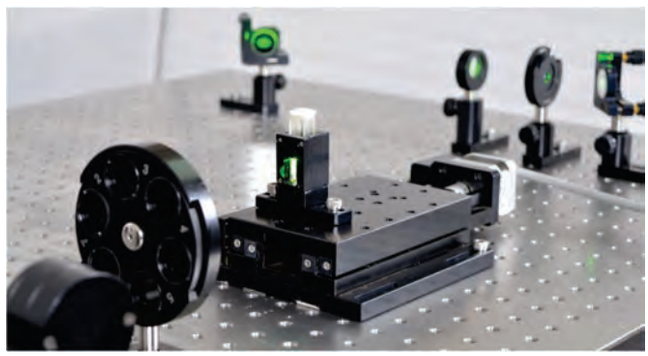
Z-Scan theoretical curves of the transmittance as a function of Z

In this method, the sample is translated along the axis of a focused Gaussian beam, and the far field intensity is measured as a function of the sample position. Analysis of the intensity versus sample position , Z-Scan curve, predicated on a local response, gives the real and imaginary parts of the third order susceptibility. In this technique, the optical effects can be measured by translating a sample in and out of the focal region of an incident laser beam.

Experiment Example:

- To measure intensity dependent nonlinear susceptibilities of materials





Scope of supply	Quantity
Optical Breadboard with rigid support(1200 x 800mm)	1 no.
DPSS laser with power supply	1 no.
Motorized linear translation stage	1 no.
Electronics control unit	1 no.
Photo detectors	2 nos.
ND Filter wheel with ND filters	1 no.
Variable aperture	1 no.
Variable beam splitter with mount	1 no.
Kinematic mirror mounts with mirrors	2 nos.
Plano convex lens with mounts	2 nos.
Circular disc with aperture	1 no
Software CD	1 no

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Spectral characteristics of LED- Grating Spectrometer

Model No: HO- ED-LOE- 04

Holmarc's grating spectrometer consists of a holographic concave diffraction grating and a one-dimensional CCD detector array. It delivers excellent thermal stability with low stray light for wide range of research and OEM applications. The concave gratings accomplish the task of two optical elements in a single, easily integrated component. It has one micrometer controlled variable input slit with LED holder.

The spectral power distribution of the optical radiation emitted by LED differs in many ways from other radiation sources. It is neither monochromatic like a laser nor broadband like a Tungsten lamp but rather lies between these two extremes. The spectrum of LED has a specific peak wavelength depending on the manufacturing process where the FWHM is typically a couple of tens of nanometres. Holmarc's grating spectrometer gives fast and reliable LED spectral characterization.

Spectrometer interfaces with a computer via Type-B USB 2.0. The entire power requirement is drawn through the 2.0 type-B USB connector. Spectra QSR software gives the output plot of intensity versus wavelength.

Experiment Examples:

- To calculate the peak wavelength of LEDs.
- To calculate the spectral bandwidth of LEDs-FWHM
- To analyze emission spectrum of laser and study the peak wavelength and FWHM .

LED Spectral characteristics

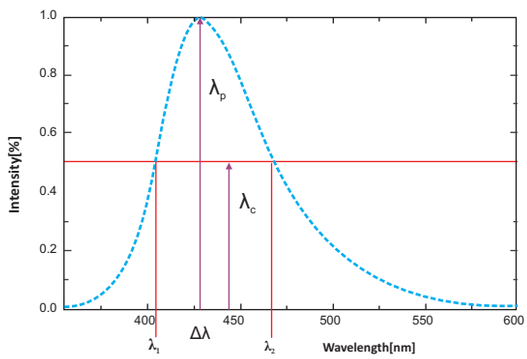
Peak wavelength λp:

Peak wavelength **λp** is the wavelength at the maximum intensity of the spectrum. The peak wavelength is easy to define and is therefore generally given in LED data sheets. However, the peak wavelength has little significance for practical purposes since two LEDs may have the same peak wavelength but different colour perceptions.

Spectral Band width FWHM:

The spectral bandwidth at half intensity, Δλ, is calculated from the two wavelengths λ_1 and λ_2 on either side of λp

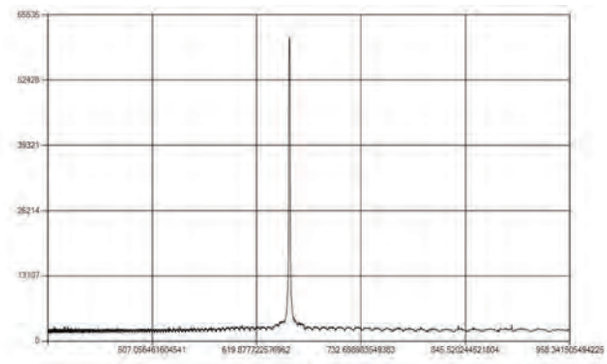
$$\Delta\lambda = \lambda_1 - \lambda_2$$



Other parameters like Centre wavelength, Centroid wavelength , Dominant wavelength, etc can be studied.

GRATING SPECTROMETER - RELATED TOPICS

- Peak wavelength
- Spectral band width
- Centre wavelength
- Centroid wavelength
- Dominant wavelength



SPECTROMETER SPECIFICATION

Spectrometer F#	2.9
Dispersion Element	Concave grating
Wavelength Range	350-1050 nm
Resolution	0.9nm
Detector	Toshiba TCD1304AP Linear CCD Array
Connectivity	USB 2.0
Software	Spectra QSR V2.26

Scope of supply	Quantity
Spectrometer	1 no.
LED with power supply	1 no.
Laser with power supply	1 no.

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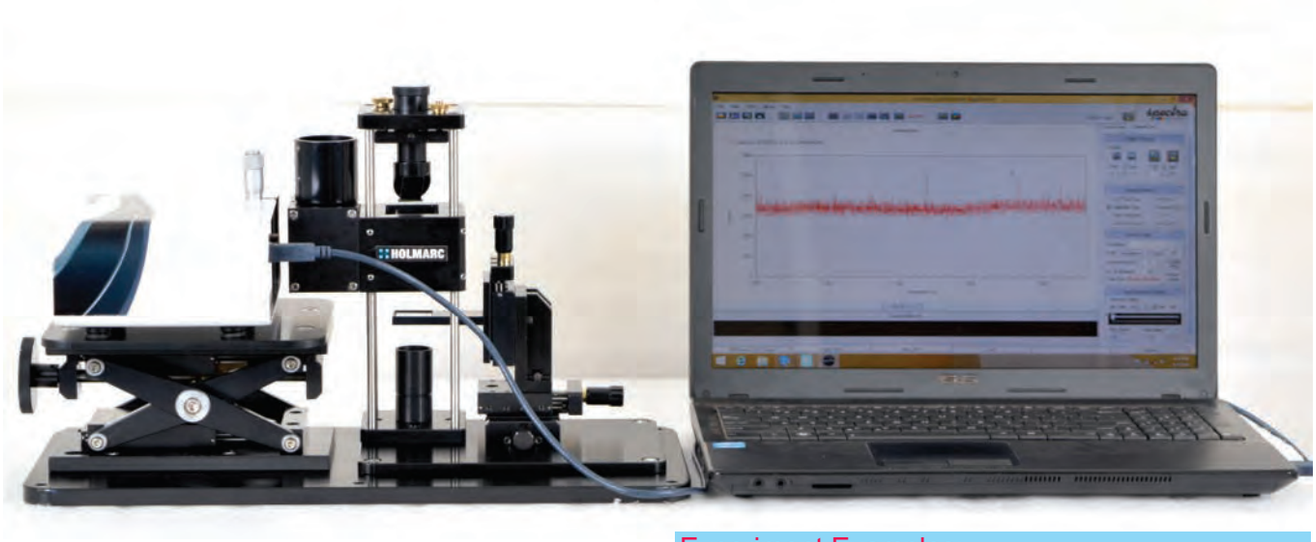
Determination of Conversion Efficiency of Crystals

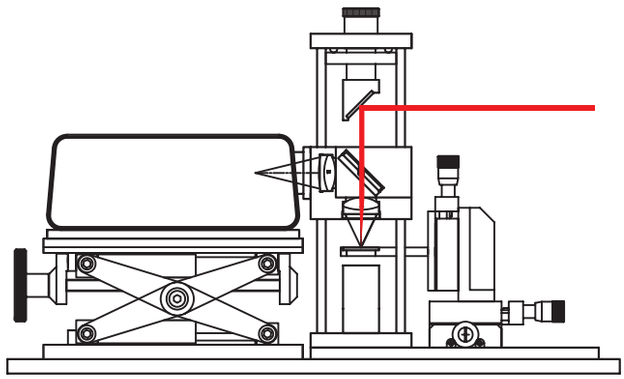
Second harmonic generation

Model No: HO-ED-LOE-05



The objective of this experiment is to observe non-linear effect, second harmonic generation in 2nd order non linear crystals. Second harmonic generation (also called frequency doubling or abbreviated SHG) is a nonlinear optical process, in which photons with the same frequency interacting with a nonlinear material are effectively "combined" to generate new photons with twice the energy, and therefore twice the frequency and half the wavelength of the initial photons.

Due to nonlinear atomic polarization, crystals can emit a different frequency of light other than absorbed. In order to see the second order effect of atomic polarization, which causes doubling in frequency of the incident light, the incident light must be intense and coherent source, like a laser. Potassium Dihydrogen Phosphate (KDP), Urea etc. are the crystals that exhibit nonlinear polarization properties. When light hits a crystal, it excites the atomic dipoles. In classical optics, it is assumed that this polarization of atoms is linear to the magnitude of electrical field of the incident light. In reality, this polarization is a nonlinear phenomenon, but the nonlinear components are evident only for high intensity.



Experiment setup

Experiment Examples:

- **Potassium Dihydrogen Phosphate (KDP) crystal growth**
- **Second harmonic generation of light - frequency doubling in Urea and KDP crystals.**
- **Comparison of SHG efficiency of urea and KDP crystals using a CCD spectrometer.**

In order for the second harmonic light to be visible in the output beam from the crystal, the atomic dipoles must be radiating constructively. This means that the second harmonic light output must be in phase with the incident laser light. The phase of the field at ω needs to be matched with the phase at 2ω in second harmonic generation. This is critical so that they do not interfere destructively. The applied electric field is strong enough such that it produces the second order radiation but the first order radiation does not become the dominant one. Hence, it can be thought of as a superposition of signals at two frequencies which should be added and not cancelled out.

In this experiment, a non centro symmetric crystal is probed with infrared laser to produce visible light. This experiment shows that frequency doubling can be achieved in urea and lab grown KDP crystals. Using a high power infrared laser we can see frequency doubling in crystals. Efficiency of emission from each crystal is calculated using standard techniques.

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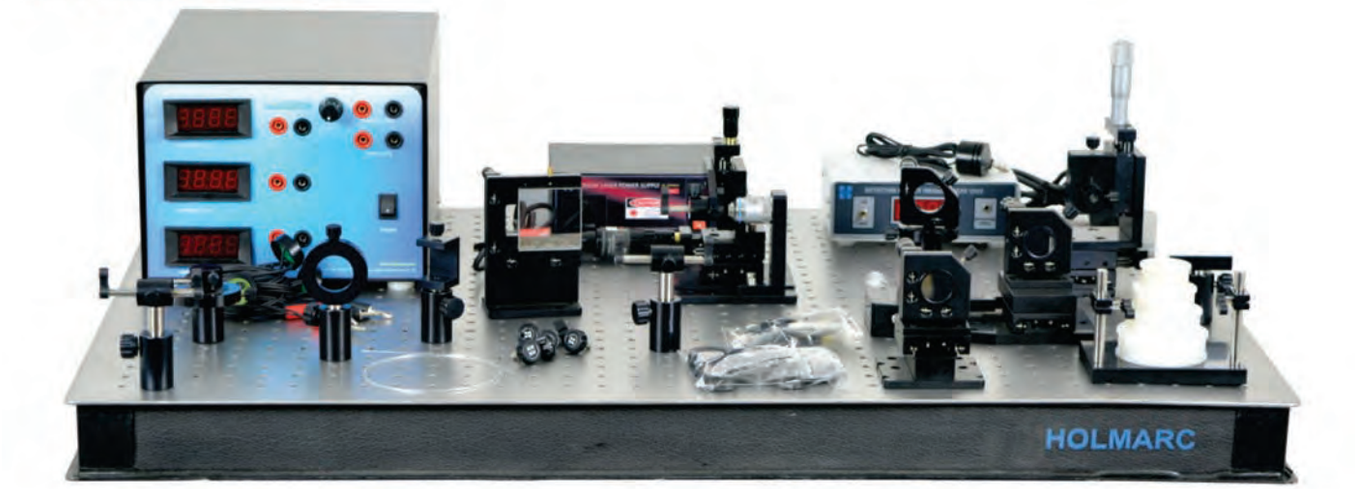
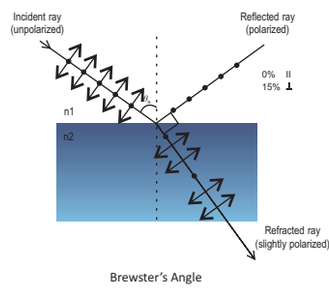
Laser Optics Lab

Model No: HO-ED-LOL-01



Holmarc's Model no: HO-ED-LOL-01 is designed for performing innovative experiments and carrying out optics related projects. It covers all the major topics such as Michelson interferometer, diffraction, opto-electronics, optical fiber, laser, polarization etc. Experimental setups can be easily assembled on the optical breadboard. Students get hands on experience and knowledge of the experiment.

The laser optics lab consists of a honeycomb optical breadboard with rigid supports and various opto - mechanical and optical components. The components are fixed to the breadboard by M6 socket head cap screws.



Brewster's Angle

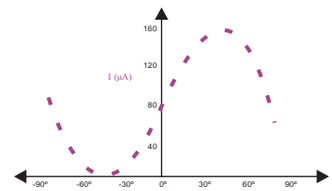


Fig. Photo detector current as a function of the angular position of polarization plane of the analyzer

Malus Law

Experiment Examples:

MICHELSON INTERFEROMETER

- Determination of wavelength of laser light.
- Determination of refractive index of transparent materials.

DIFFRACTION

- Diffraction of light by single slit.
- Diffraction of light by double slit.
- Diffraction of light by transmission grating
- Diffraction of light by single wire.
- Diffraction of light by cross wire.
- Diffraction of light by fine wire mesh.
- Diffraction of light by pinhole.
- Particle size determination.
- Use of meter scale ruling as reflection grating.
- To find the groove spacing of a CD by using it as reflection grating.

LASER

- Gaussian nature of the laser beam.
- Beam spot measurements.
- Divergence measurement.
- Polarization nature of laser.

OPTICAL FIBER

- Numerical aperture measurements.
- Determination of bending loss in multi-mode fibers.

OPTO-ELECTRONICS

- Characteristics of photo transistor.
- Characteristics of photo diode.
- Characteristics of light dependent resistor (LDR).
- Characteristics of solar cell.
- Characteristics of light emitting diode (LED).
- Characteristics of opto - coupler.

POLARIZATION

- Polarization of light and verification of Malus law.
- Determination of refractive index of transparent material by finding Brewster's angle.

ABSORPTION

- Study of absorption of laser light in various filters.

TOTAL INTERNAL REFLECTION

- Determination of refractive index of PMMA rod.
- Determination of refractive index of liquids.

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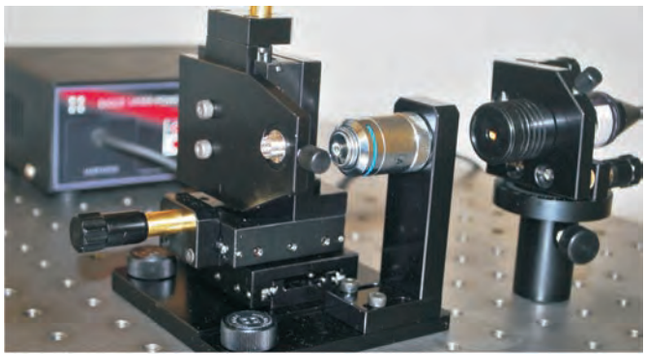

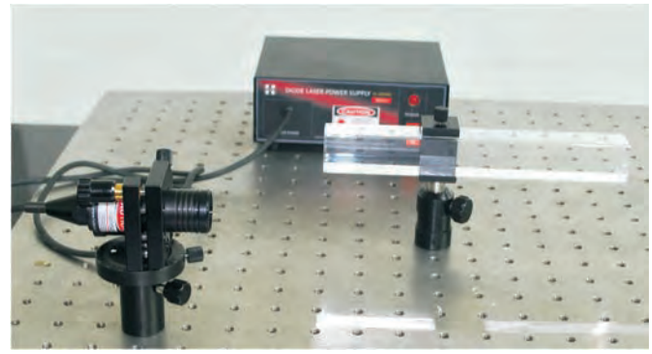

Scope of supply	Quantity
Optical Breadboard with rigid support (800x600mm)	1 No
Kinematic laser mount	1 No
Beam splitter mount	1 No
Mirror mount with translation stage	1 No
Mirror mount with precision translation stage	1 No
Rotation stage	1 No
Screen with mount(75x75 mm)	1 No
Cell mount	1 No
XYZ translation stage(Resolution 0.01mm)	1 No
Laser fiber coupler (Magnification 10X)	1 No
Fiber chuck holder	1 No
PMMA rod mount	1 No
Bending loss apparatus	1 No
Fiber chuck	1 No
Polarizer rotator with mount(Resolution 1°)	1 No
Meter scale mount	1 No
PMMA Rod	1 No
Multi mode optical fiber(735,240 microns)	2 Nos.
Mirror with cell(Φ25 mm)	2 Nos
Beam splitter(50x50 mm)	1 No
Plano convex lens with cell(Φ30 mm)	1 No
Diffraction Cells	7 Nos
Color filters	4 Nos
Glass tank(100x100x50 mm)	1 No
Mounted opto - electronic detectors	6 Nos
Opto - electronic measurement unit(230V AC / 50Hz)	1 No
Diode laser with power supply (650 nm,5mW)	1 No
Diode laser with power supply for characterization (650 nm,3mW)	1 No
Diode laser with power supply for Michelson expt. (650 nm,5mW)	1 No
Detector with output measurement unit	1 No

Features:

- Easy to assemble experiment set up on an optical breadboard.
- Rigid and portable support for optical breadboard.
- Provides variety of components in a single package.
- Ideal for the study of various properties of light.
- Mechanical components are made out of anodized aluminum and stainless steel.
- Precision optical components.

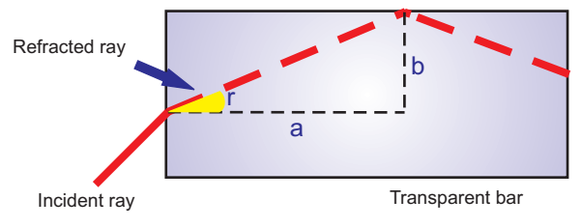

Fig. An illustration of total internal reflection of light which is incident on a PMMA rod

Total internal reflection is an optical phenomenon that happens when a ray of light strikes a medium boundary at an angle larger than the critical angle with respect to normal to the surface. If the refractive index is lower on the other side of the boundary and the incident angle is greater than the critical angle, no light can pass through and all of the light is reflected. Laser Optics Lab is designed to perform more than 30 experiments using diode laser. Instruction manual with complete information and diagrams is provided along with the apparatus.

Model : DAC216-S286

Specifications

Angular Range
Horizontal : 2053.43 Arc Sec
Vertical : 1540.073 Arc Sec

Angular Resolution
Maximum : 0.79 Arc Sec
Minimum : 3.21 Arc Sec

Readout Rate
Maximum : 0.059 Sec
Minimum : 0.25 Sec

Advantages:
- ★ High precision.
- ★ Real-time measurements.
- ★ User-friendly interface.
- ★ Creating data reports and transferring to other programs.

Readout Rate Vs. Resolution

17fps	3.21Arc Sec
10fps	1.60 Arc Sec
9fps	1.07Arc Sec
6fps	1 Arc Sec
4fps	0.79Arc Sec

Operational Range (Full Angular Range)
Minimum : 0m
Maximum : 1.83m

Minimum measurement : 10 mm diameter mirror at 1.5 m.

Illumination Source : Laser or LED
Battery : Rechargeable 18650 Li-ion
Battery Backup for the Illumination : 16-22 Hrs

Measurement Mode : Fully automatic- PC based
Interface : USB 2.0
Measurement Axis : X & Y

Digital Autocollimator **DAC**216 Series

HOLMARC DAC216 series Autocollimators are PC-based instruments which are designed to operate in laboratories as well as in a machine shop environment. No external controller is required. The standard interface is a single USB connection for power input and data output. It can be used for precision measurements, testing and alignment processes, where highest precision and reliability in angle detection is important.

DAC216 series Autocollimators are high-precision dual axis angle measurement system that utilizes digital imaging technologies to measure two angular positions relative to the reflective surface. Their exceptional accuracy and high resolution make them suitable for applications including calibration of rotary tables, verification of angle standards and for remote or long term angular monitoring operations. The main applications are in calibration laboratories, optics labs, opto-elecronic laboratories and productions, laser based industries, space laboratories, etc.

For faster measurement

Faster measuring autocollimators are used for applications such as scanning

Specifications

Model	DAC216-F286A	DAC216-F286B
XY Measurement range	3470 x 2739 Arc Sec	2053 x 1540 Arc Sec
Resolution	5.4 Arc Sec	3.2 Arc Sec
Clear aperture	40mm	
Illumination	Laser or LED	
Rate of measurements	120 fps.	
Minimal reflector diameter	Ø10mm (mirror) Ø30mm (glass)	
Operational range	1.5m	
Interface	USB 3.0	

For high resolution measurement

Specifications

Model	DAC216-R900A	DAC216-R900B
XY Measurement range	737 x 527 Arc Sec	653 x 490 Arc Sec
Resolution	0.16 Arc Sec	0.25 Arc Sec
Illumination	Laser or LED	
Rate of measurements	120 fps.	
Minimal reflector diameter	Ø10mm (mirror) Ø30mm (glass)	
Operational range	1.5m	
Interface	USB 3.0	

Diffraction is a wave property of electromagnetic radiation that causes the radiation to bend as it passes by an edge or through an aperture. Diffraction effects increase as the physical dimension of the aperture approaches the wavelength of the radiation. Diffraction of radiation results in interference that produces dark and bright rings, lines or spots depending on the geometry of the object causing the diffraction.

Screen Based Apparatus for Diffraction Experiments 44
Model No: HO-ED-D-01

Detector Based Apparatus for Diffraction Experiments 45
Model No: HO-ED-D-02

Goniometer Based Apparatus for Diffraction Experiments 46
Model No: HO-ED-D-03

Apparatus for Studying Diffraction from Reflection Grating 47
Model No: HO-ED-D-04

Apparatus for Determination of Particle Size 48
Model No: HO-ED-D-05

Fresnel's Biprism Diffraction Apparatus 49
Model No: HO- ED-D-07

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Screen Based Apparatus for Diffraction Experiments

Model No: HO-ED-D-01

The apparatus Model No: HO-ED-D-01 is meant for studying diffraction when laser light passes through a diffracting element. The device consists of diode laser and diffracting element that can be conveniently fixed on carriages, which are mounted on the anodized aluminum rail. One carriage holds laser head and the other carriage holds a diffracting element like single slit, double slit, etc. which can be replaced as per requirement.

The laser mount is kinematic with two dimensional positioning freedoms. This helps to direct the laser beam to the required point on the diffracting element. All materials used for the construction of this apparatus are corrosion free. The diffraction pattern is projected on to a screen or wall for performing experiments. This elementary apparatus is simple, economical and is well suited for graduate level Physics courses.

SCREEN BASED APPARATUS FOR DIFFRACTION EXPERIMENTS - Related Topics

- Single slit
- Double slit
- Single wire
- Cross wire
- Wire mesh
- Transmission grating
- Circular aperture (pin hole)

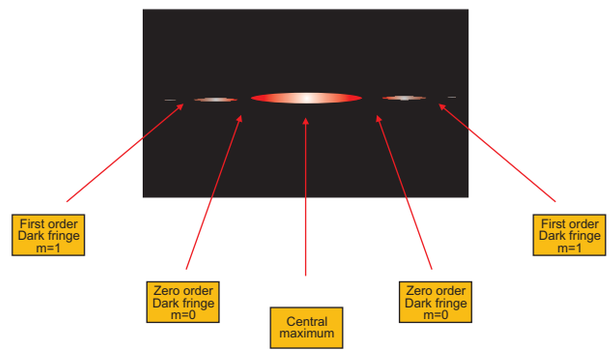
Features:

- Modern and user Friendly design
- Precision diffraction elements
- Fine adjustments for laser mount
- Sharp diffraction pattern
- Simple and easy operation

Experiment Examples:

- Diffraction of light by single slit
- Diffraction of light by double slit
- Diffraction of light by single wire
- Diffraction of light by cross wire
- Diffraction of light by wire mesh
- Diffraction of light by transmission grating
- Diffraction of light by circular aperture (Pinhole)

A diffraction element can be thought of as an optical component that has tiny grooves cut into it. The grooves are cut so small that their dimensions approach the wavelength of light.



Scope of supply	Quantity
Optical rail (500 mm)	1 no.
Kinematic laser mount	1 no.
Cell mount (Diameter 30mm)	1 no.
Diffraction cells	1 set.
White screen (Acrylic)	1 no.
Diode laser with power supply(650 nm,3mW)	1 no.

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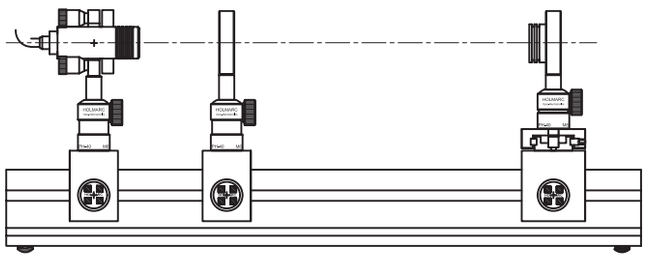
Detector Based Apparatus for Diffraction Experiments

Model No: HO-ED-D-02

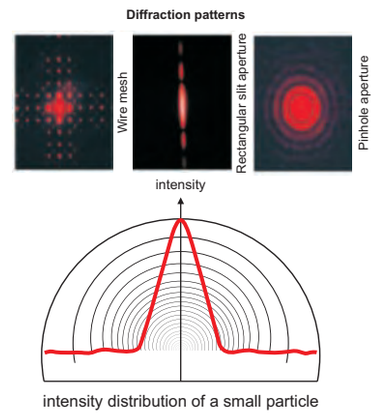
This apparatus (Model No: HO-ED-D-02) is meant for graduate and post graduate level courses in physics. Here, the diffraction pattern is closely studied using a detector mounted on translation stage. The device consists of one meter long optical rail along with carriages, optics and opto- mechanics. At one end of the rail, X- translation stage with detector is mounted and at the other end, laser is held on a kinematic mount. Linear scale attached to the rail makes length measurement easy and convenient. Both the laser head and detector stages are mounted on rail carriages with locks, which in turn can be mounted anywhere on the rail conveniently.

Experiment Examples:

- Diffraction of light by single slit
- Diffraction of light by double slit
- Diffraction of light by single wire
- Diffraction of light by cross wire
- Diffraction of light by wire mesh
- Diffraction of light by transmission grating
- Diffraction of light by circular aperture (Pinhole)



In this apparatus, diffraction experiments are carried out with a photo sensitive detector and laser is used as light source. The diffraction element is placed at a certain distance from the detector and the pattern is allowed to fall on the detector stage. The micrometer driven stage is used to move the detector to extreme end of the diffraction pattern and the intensity is noted at close intervals by traversing the detector through the cross section of the spectrum. The intensity versus distance curve is plotted on a graph for calculations.



intensity distribution of a small particle

Features:

- High measurement accuracy, clear and sharp diffraction patterns
- Diffraction elements are fixed to metallic casing for ease of mounting
- Smooth switch on and long lifetime of light source
- Reliable and affordable

DETECTOR BASED APPARATUS FOR DIFFRACTION EXPERIMENTS - Related Topics

- Single slit
- Double slit
- Single wire
- Cross wire
- Wire mesh
- Transmission grating
- Circular aperture (pin hole)

Scope of supply	Quantity
Optical rail (1000 mm)	1 no.
Kinematic laser mount	1 no.
Cell mount (Diameter 30mm)	1 no.
Detector mount with X-translation (Resolution 0.01mm)	1 no.
Diffraction cells	1 set.
Diode laser with power supply(650nm,3mW)	1 no.
Detector with output measurement unit	1 no.

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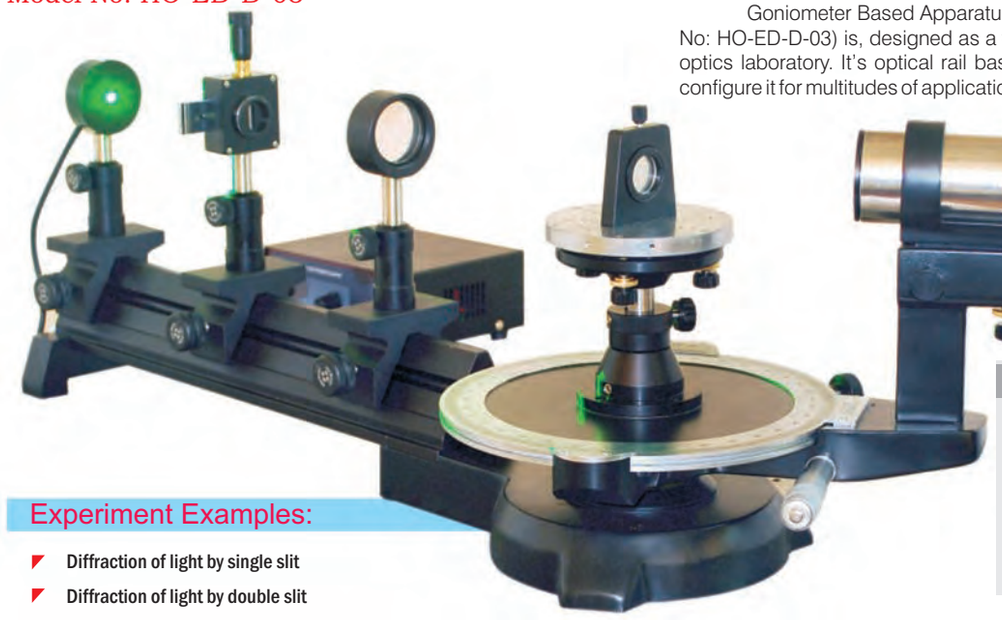
Goniometer Based Apparatus for Diffraction Experiments

Model No: HO-ED-D-03



Goniometer Based Apparatus for diffraction experiments (Model No: HO-ED-D-03) is, designed as a versatile instrument suitable for any optics laboratory. It's optical rail based construction allows the user to configure it for multitudes of applications.

GONIOMETER BASED APPARATUS - Related Topics

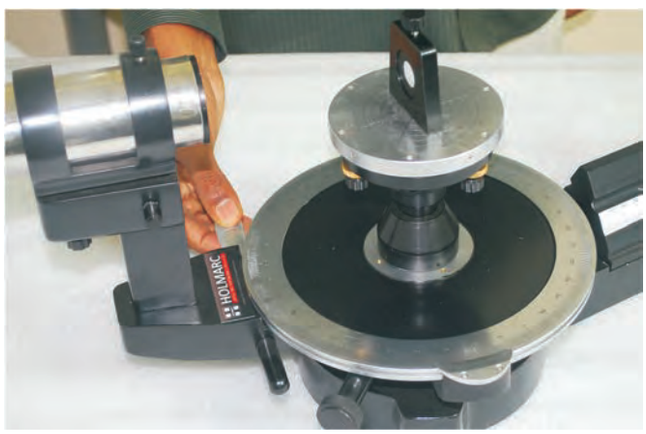
- Single slit
- Double slit
- Single wire
- Cross wire
- Wire mesh
- Transmission grating

Experiment Examples:

- **Diffraction of light by single slit**
- **Diffraction of light by double slit**
- **Diffraction of light by single wire**
- **Diffraction of light by cross wire**
- **Diffraction of light by wire mesh**
- **Diffraction of light by transmission grating**

The apparatus can be used for studying both reflecting and transmitting type diffracting elements. Unlike conventional spectrometer-goniometers, all modules in this device are open, simple and easy to assimilate. This feature gives students better understanding .

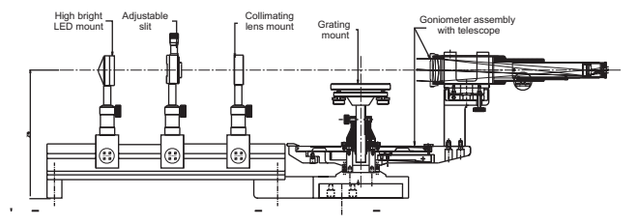
The apparatus can also be used for many other applications like measurement of prism angles, refraction angle etc., where spectrometer-goniometers are generally used. All components are made from corrosion free laboratory grade materials. Optical components are made of research quality N-BK 7 optical glass.



This apparatus consists of a goniometer for measuring diffraction angle directly and a precision adjustable slit through which light passes before falling on the diffracting element. The function of goniometer and positioning stage is to establish and control the geometric relationship between the incident beam, diffraction cell and telescope. The goniometer is also the supporting base to many components, such as the optics, diffraction cell stage, telescope and so on. The equipment is specifically suited for studying elements with considerably greater diffraction angles, like holographic gratings. As the readings are taken through an eyepiece with cross wire, precise results are achieved.

Features:

- **Modern, versatile and user friendly design**
- **Precision optical Instrument**
- **Angular adjustments for telescope possible**



Scope of supply	Quantity
Goniometer	1 no.
Optical rail (300mm)	1 no.
Silt with mount (Slit Size 0 - 3mm)	1 no.
Collimating lens with mount (Diameter 50mm)	1 no.
Telescope (Magnification 10X)	1 no.
Cell mount (Diameter 30 mm)	1 no.
Diffraction cells	1 set.
High bright LED with power supply	1 no.

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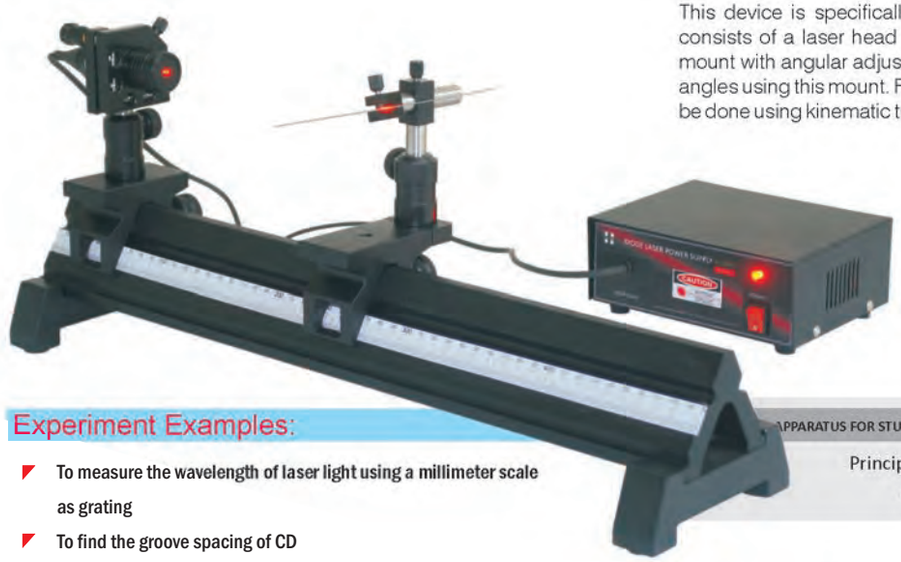
Apparatus for Studying Diffraction from Reflection Grating

Model No: HO-ED-D-04



This device is specifically designed for studying reflection gratings. It consists of a laser head mounted on a kinematic holder and a grating mount with angular adjustments. The grating can be fixed at appropriate angles using this mount. Fine adjustments in grazing or incident angle can be done using kinematic tuning of the laser mount.

Both the laser and grating mounts are fixed on rail carriers, which are held on a graduated solid aluminum rail. The diffraction pattern is projected on a screen or wall. When a meter scale is used as reflection grating, the pattern can be observed typically at two to three meters.

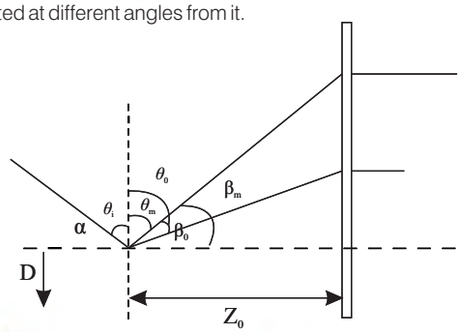
Experiment Examples:

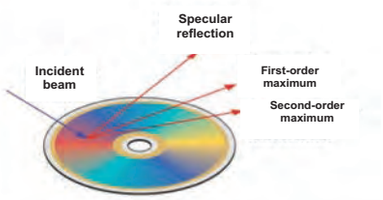
- To measure the wavelength of laser light using a millimeter scale as grating
- To find the groove spacing of CD

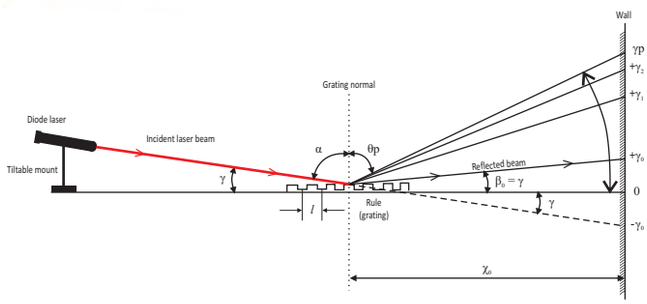
APPARATUS FOR STUDYING DIFFRACTION FROM REFLECTION GRATING - Related Topics

Principle of gratings | Diffraction order | Groove space | Reflection grating

Compact Disc and the meter scale consists of a series of evenly spaced (reflective) grooves and ridges that act as a diffraction grating. The grooves in a compact disc are very close together. CD and the millimeter scale are reflective and therefore the diffraction pattern can be observed by looking at the reflected pattern. The spectrum of colors can be seen reflected from a compact disc. The closely-spaced tracks on the surface of the disc form a diffraction grating, and the individual wavelengths of white light are diffracted at different angles from it.







Features:

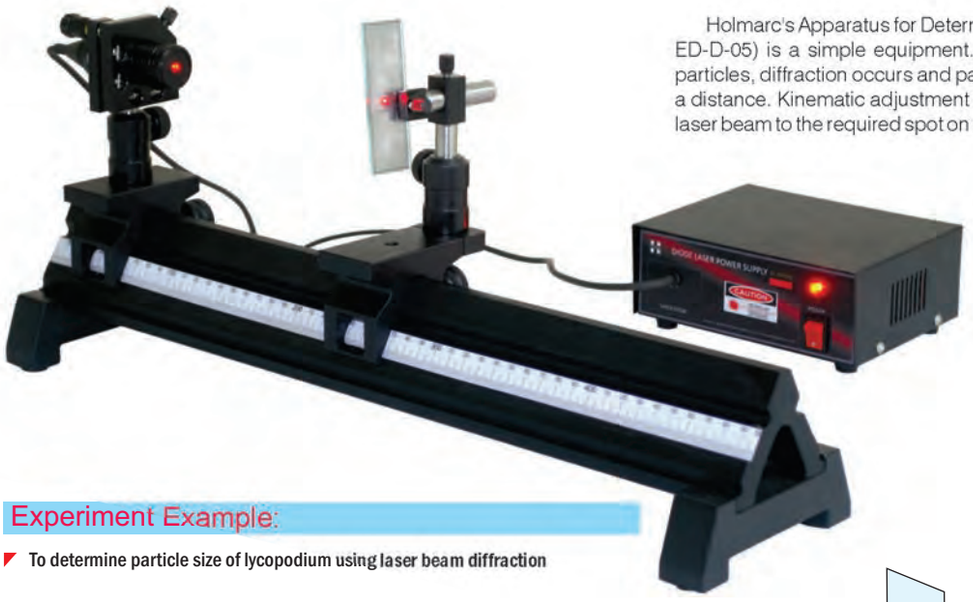
- Sharp, clearly visible diffraction pattern
- Simple, economical and relatively compact
- Specimen holder provides angular and height adjustment
- Fine adjustments in grazing angle can be done using kinematic laser mount

Scope of supply — Quantity

Optical rail (500mm length)	1 no.
Kinematic laser mount (Adjustment Range +/-4 degrees)	1 no.
Specimen holder with mount (Cavity Thickness 3mm)	1 no.
Reflection gratings (Millimeter scale and CD)	1 no each.
Diode laser with power supply (650nm,3mW)	1 no.

Apparatus for Determination of Particle Size

Model No: HO-ED-D-05



Holmarc's Apparatus for Determination of Particle size (Model No: HO-ED-D-05) is a simple equipment. When laser light passes through the particles, diffraction occurs and pattern is observed on a screen or wall at a distance. Kinematic adjustment of the laser head can be used to direct laser beam to the required spot on the glass slide with particle.

The device consists of a diode laser held on a kinematic mount and a glass slide fixed on the slide holder. The particles, of which diameters are to be determined are sprinkled on the glass slide.

PARTICLE SIZE APPARATUS - Related Topics

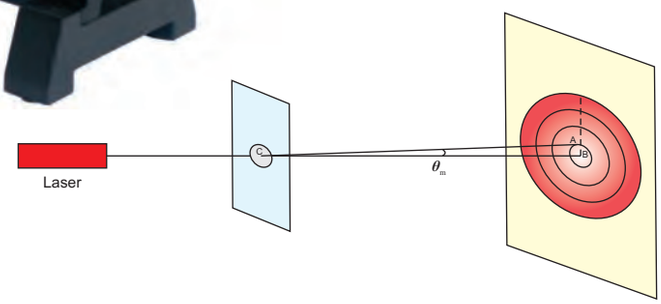
Diffraction ◀ Angle of diffraction ◀

Experiment Example:

- To determine particle size of lycopodium using laser beam diffraction

Both the laser and slide holder are fixed on rail carriers which are held on a graduated solid aluminum rail. Particle size influences many properties of particulate materials and is a valuable indicator of quality and performance. The size and shape of powders influences it's diffraction characteristics. The diffraction pattern of larger particles will have less distance between the first dark ring and the central maximum than that of smaller ones. There are several industrial and research applications where measurement of particle size is important.

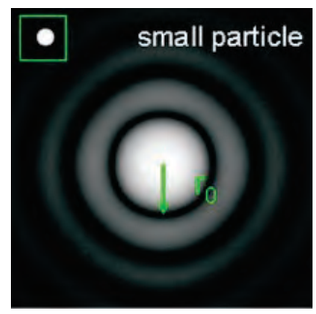
The laser diffraction technique is based on the fact that the spatial distribution of scattered light is a function of the particle size of the sample.

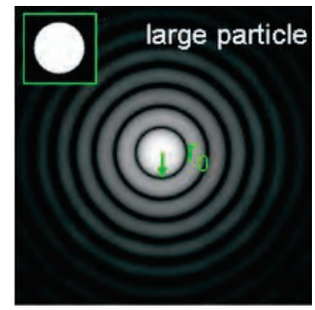


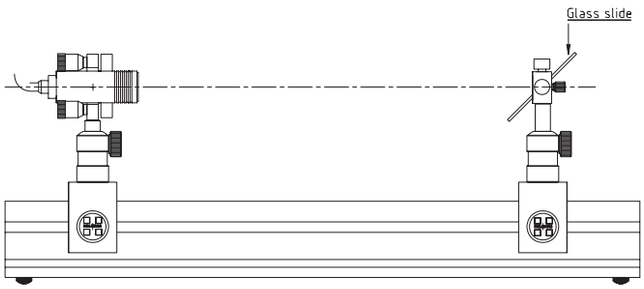
Features:

- Easy to perform
- Relatively simple and compact design
- Each particle can be individually examined
- Highly versatile

Classification of Powders by Fineness	
Classification of Powders	Particle Size(μm)
Very Coarse	>1000
Coarse	355-1000
Moderately Fine	180-355
Fine	125-180
Very Fine	90-125







Scope of supply	Quantity
Optical rail (500 mm)	1 no.
Kinematic laser mount	1 no.
Specimen holder with mount	1 no.
Glass slide	5 nos.
Diode laser with power supply (3mW/650nm)	1 no.

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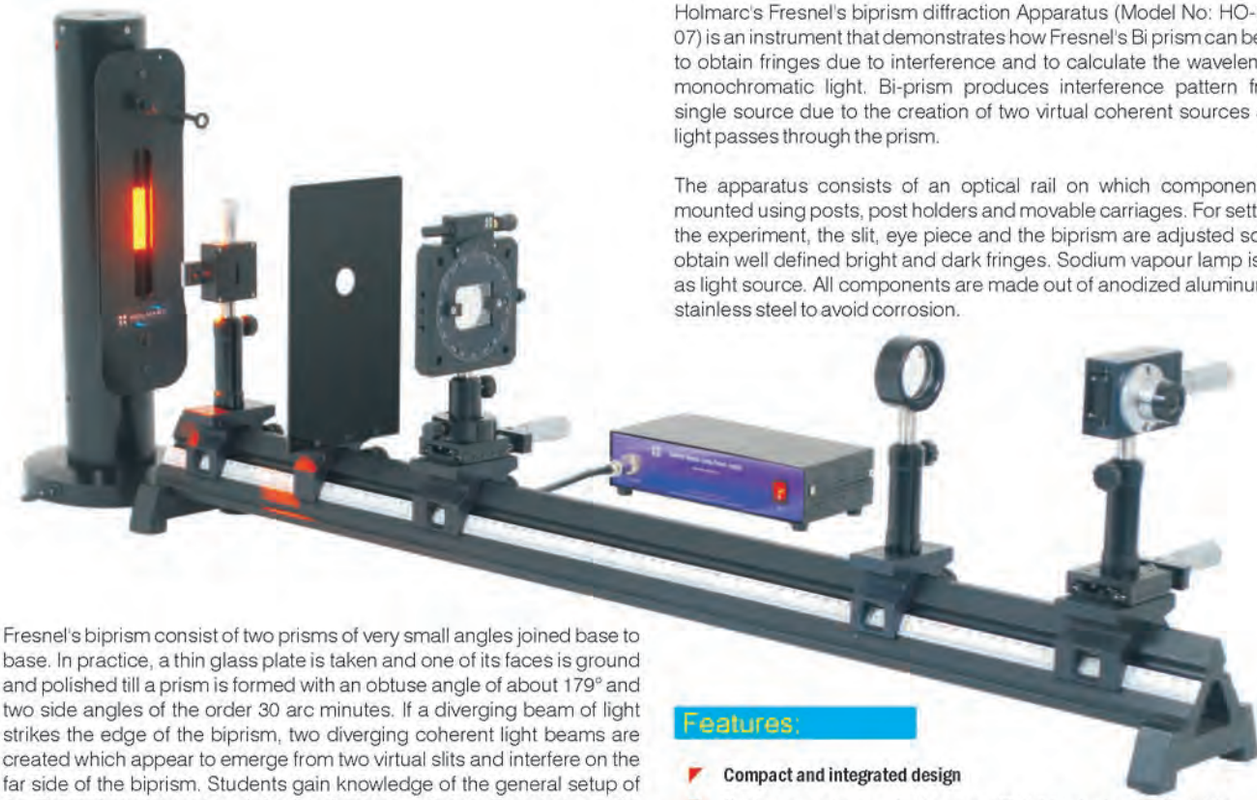
Fresnel's Biprism Diffraction Apparatus

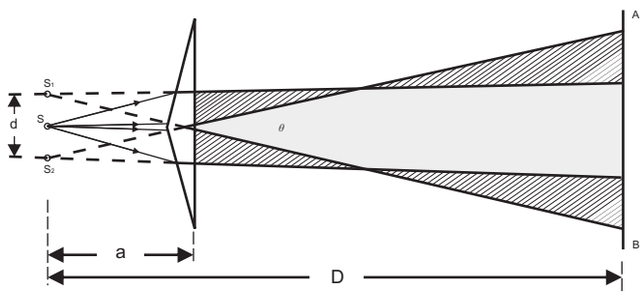
Model No: HO-ED-D-07

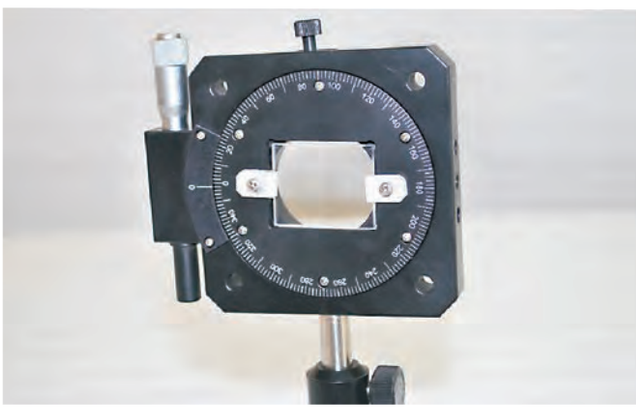


Holmarc's Fresnel's biprism diffraction Apparatus (Model No: HO-ED-D-07) is an instrument that demonstrates how Fresnel's Bi prism can be used to obtain fringes due to interference and to calculate the wavelength of monochromatic light. Bi-prism produces interference pattern from a single source due to the creation of two virtual coherent sources as the light passes through the prism.

The apparatus consists of an optical rail on which components are mounted using posts, post holders and movable carriages. For setting up the experiment, the slit, eye piece and the biprism are adjusted so as to obtain well defined bright and dark fringes. Sodium vapour lamp is used as light source. All components are made out of anodized aluminum and stainless steel to avoid corrosion.

Fresnel's biprism consist of two prisms of very small angles joined base to base. In practice, a thin glass plate is taken and one of its faces is ground and polished till a prism is formed with an obtuse angle of about 179° and two side angles of the order 30 arc minutes. If a diverging beam of light strikes the edge of the biprism, two diverging coherent light beams are created which appear to emerge from two virtual slits and interfere on the far side of the biprism. Students gain knowledge of the general setup of the Fresnel experiment and the interference patterns. Research quality modules of the instrument can be used for project works as well.





Features:

- Compact and integrated design
- Sodium vapor lamp as light source with light output port adjustable in length
- Precision lead screw driven slit provided with a maximum opening of 3mm
- Eyepiece with micrometer drive for achieving perfect linear motion
- Precision rotary coarse and fine adjustments with lead screw controller in biprism mount
- Achromatic lens is used for focusing image

Experiment Example:

- To find the wavelength of the sodium light using bi-prism diffraction experiment

FRESNEL'S BIPRISM DIFFRACTION APPARATUS - Related Topics

Fresnel biprism | Interference | Virtual coherent sources

Scope of supply	Quantity
Optical rail (1200 mm)	1 no.
Silt with mount (Slit Size 0 - 3mm)	1 no.
Biprism mount (Coarse 360°)	1 no.
Achromatic lens with mount(Focal length 202 mm)	1 no.
Eye piece with micrometer drive (Least Count 0.01mm)	1 no.
Black screen with mount (Acrylic)	1 no.
Bi prism (Borofloat)	1 no.
Sodium vapor lamp with power supply (35W)	1 no.

Faraday Modulator - Polarization Modulation

In Faraday Effect, the phase modulation of two mutually perpendicular components of linearly polarized light results polarization modulation, which is then transformed into amplitude modulation by analyzer. The magneto-optic modulators are based on the rotation of optical polarization as light propagates along the magnetic field in a material, by the Faraday effect. Like intensity modulation, polarization modulation does not require sophisticated stabilized laser. Since, optical sensitivity of a polarization modulated light is about twice as high as intensity modulated signal, it provides better receiver signal to noise ratio (SNR).

Our modulator is made of MR3-2 Faraday material placed inside a solenoid coil with modulating electric current. Water cooling system is used for longer operation for which water inlet and outlet connectors are provided on the top of the device.

Applications,
Polarimetry & Other Optical Rotation Measurements
Magneto-Optic Kerr Effect
Faraday Modulation Spectroscopy (FAMOS)
Optical Communication

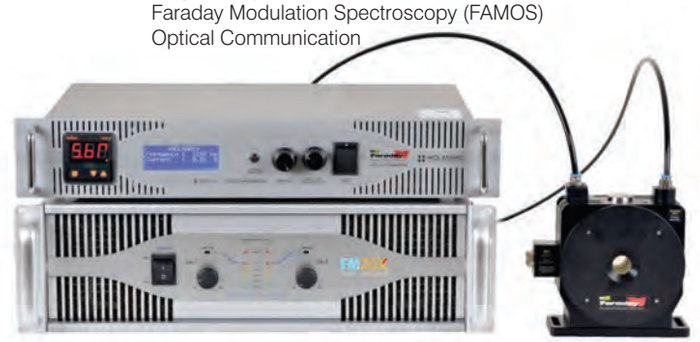


Fig. Modulator power amplifier & signal generator and control unit.

Fig. HO-FM20C Faraday Modulator

Since glass material in high power laser system can be damaged as a consequence of self-focusing, low non-linear refractive index as well as high Verdet constant are important factors for Magnetic Optical Glass. The MR3-2 glass is made by considering all these factors. It is stable, sensitive and inherently immune to interference.

The optical Specifications :

Faraday Rotator Glass : MR3-2 glass
Verdet constant: -0.329min/Oe*cm at 632.8nm and -0.108 min/Oe*cm at 1064nm
Absorption coefficient: < 0.002 per cm at 1064nm
Transmission: ≥ 86% without AR coating
Bulk laser damage threshold for material: > 25 (Joules/cm^2) at 1064nm, 10ns pulses
For stress birefringence, extinction ratio to perpendicular polarization > 40 dB

Fig. Water Cooler for Faraday Modulator >>>

Model	Aperture	Wavelength Range (nm)
HO-FM05C	5mm	380 - 1100nm
HO-FM10C	10mm	**Frequency Range (Hz)**
HO-FM015C	15mm	200-5000Hz
HO-FM20C	20mm	**Resolution : +/-1Hz**

The Faraday modulator used for the polarimeter has important functions other than providing an easy way of optimizing the signal to noise ratio. It allows the real and imaginary parts of the refractive indices to be separated. This stems from the fact that in the modulator there is very little absorption i.e. the effect is only to modulate the angle of rotation of the linearly polarized laser beam with negligible modulation of the phase or ellipticity of the light.

In geometrical optics, the ray approximation is combined with the laws of reflection, refraction and geometry to determine the location and size of an image formed by a reflecting or refracting surface. This approach can be applied to single surfaces such as mirrors, multiple surfaces such as lenses and multi component systems such as telescopes. Optical science is relevant in many related disciplines including astronomy, various engineering fields, photography and medicine particularly ophthalmology and optometry.

Liquid Lens Apparatus
Model No: HO-ED-O-01 51

Geometrical Optics Experiment Apparatus
Model No: HO-ED-O-02 52

Refractometer-Basic model
Model No: HO-ED-O-03 53

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Liquid Lens Apparatus

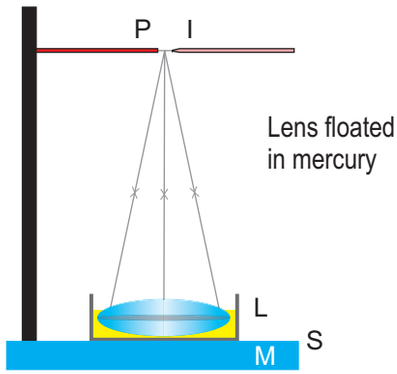
Model No: HO-ED-O-01

Holmarc's Liquid Lens Apparatus (Model No: HO-ED-O-01) is designed for the determination of refractive index of a given liquid. With its new design and features, one can easily understand the principles and practices involved.

The theory behind the liquid lens is based on the properties of one or more liquids to create magnifications within a small amount of space. The focus of a liquid lens is controlled by the surface of the liquid. The surface profile of the liquid determines the focal length of liquid lens system and how the liquid lens focuses light rays.

Experiment Examples:

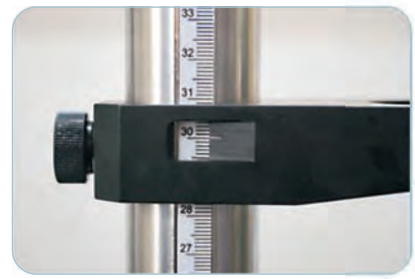
- To determine the focal length of convex lens
- To determine the focal length of liquid lens
- To find the refractive index of liquid

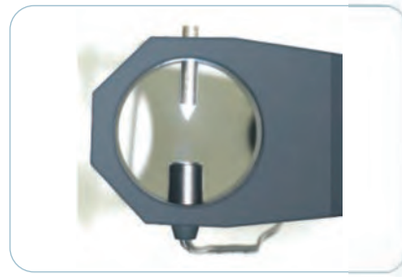


This apparatus consists of graduated vertical post with rigid base along with a light source and required optics. A pointer illuminated with LED is mounted on the vertical post. The illumination helps to conduct the experiment even in low light conditions. The pointer is free to move along the axis of the vertical post and can be easily clamped at desired positions.

Features:

- Illumination with bright LED
- Easy alignment
- Lower cost and easy maintenance
- Superior quality precision optics

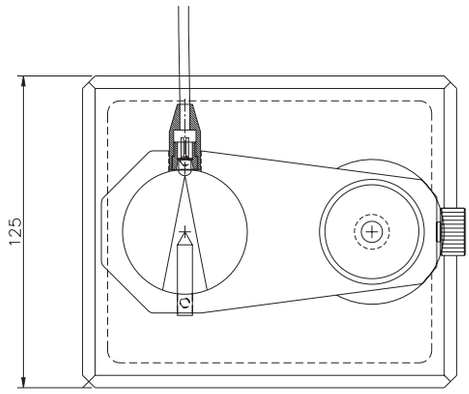




LIQUID LENS APPARATUS - Related Topics

- Liquid lens
- Focal length
- Refractive index

The liquid lens arrangement is kept on a rigid base. The pointer is raised or lowered till the tip of its image coincides with the tip of the pointer without parallax. The distances of the pointer from the top and bottom of the lens are measured. The experimental setup includes three convex lenses of different focal lengths and a plane mirror. A petri dish carrying liquid is also included in this setup.



Scope of supply	Quantity
Retort stand with rigid base (0-500mm Vertical)	1 no.
Pointer holder with carriage	1 no.
Petri dish	1 no.
Back coated plane mirror(50mm)	1 no.
Bi- convex lens(100,200,300mm)	1 no each.
LED with power supply	1 no.

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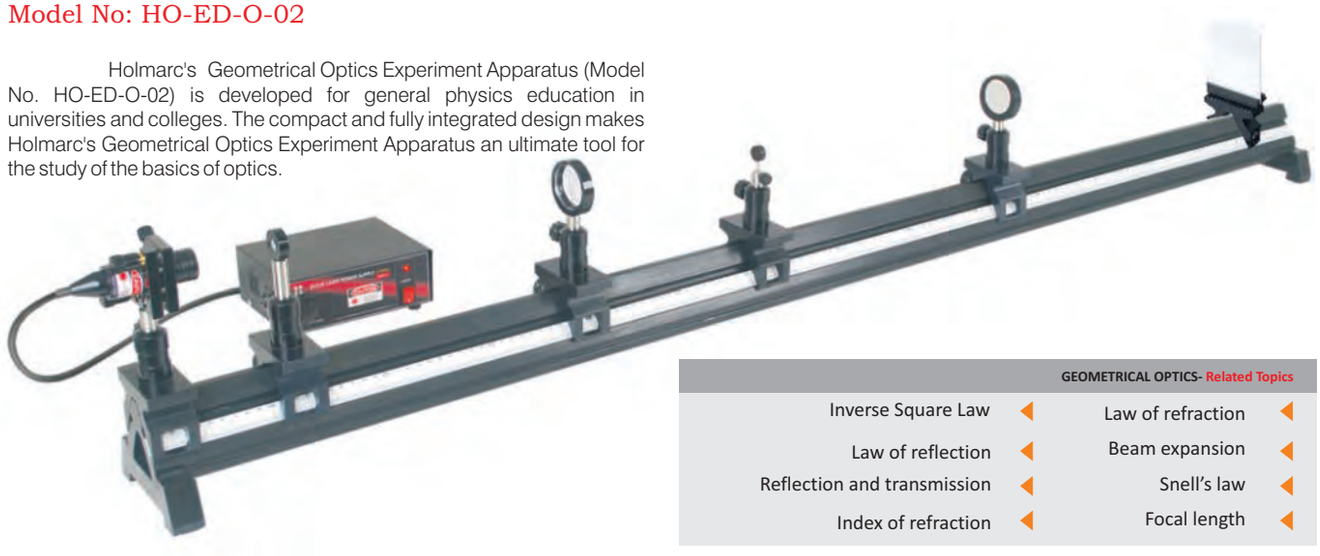
Geometrical Optics Experiment Apparatus

Model No: HO-ED-O-02

Holmarc's Geometrical Optics Experiment Apparatus (Model No. HO-ED-O-02) is developed for general physics education in universities and colleges. The compact and fully integrated design makes Holmarc's Geometrical Optics Experiment Apparatus an ultimate tool for the study of the basics of optics.



GEOMETRICAL OPTICS- Related Topics	
Inverse Square Law	Law of refraction
Law of reflection	Beam expansion
Reflection and transmission	Snell's law
Index of refraction	Focal length

Experiment Examples:

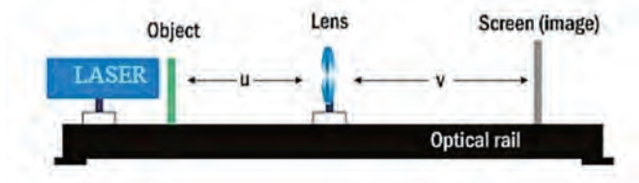
- To measure the focal length of convex lens, concave lens, convex mirror and concave mirror using
  - i. Parallel Beam Method
  - ii. U –V Method
- To verify inverse square law
- To verify law of reflection
- To verify law of refraction and to find the refractive index of water
- To construct laser beam expander
- To construct collimator
- To construct simple and compound microscopes

Features:

- Applicable to all kinds of basic optics experiments
- Simple and convenient to set up each experiment

It includes 1500mm long graduated optical bench with carriers. The optical components such as lenses, mirrors, etc. are fixed to the carriers using suitable mounts so that these can be fixed anywhere on the rail.

Students can easily adjust positions of optical devices using the sliding carriers. All the accessories are easy to be mounted and adjusted. The apparatus includes set of lenses, concave/convex mirrors, light sources like laser, LED etc. The use of diode laser as light source makes the ray path visible and helps students to assimilate the basics easily.



Scope of supply	Quantity
Goniometer with detector mount	1 no.
Optical rail (1500mm)	1 no.
Kinematic laser mount	1 no.
White screen with mount	1 no.
Wire gauze with mount	1 no.
Hollow screen with mount	1 no.
Spatial filter assembly (Magnification 10X)	1 no.
Microscope assembly with mount (Magnification 10X)	1 no.
Obstacle with mount	1 no.
Divergence lens with mount	1 no.
Convex lens with mount	2 nos.
Concave lens with mount	2 nos.
Convex mirror with mount	2 nos.
Concave mirror with mount	2 nos.
Glass tank(50x50x50mm)	1 no.
Detector with output measurement unit	1 no.
LED with variable power supply	1 no.
Diode laser with power supply (RED) (650nm/5mW)	1 no.

Refractometer- Basic model

Model No: HO-ED-O-03

Holmarc's Refractometer (Model No: HO-ED-O-03) is designed for understanding the basics of refractometry. It can visualize the output on a screen. One can do the calibration and can obtain the refractive index of various types of liquids.

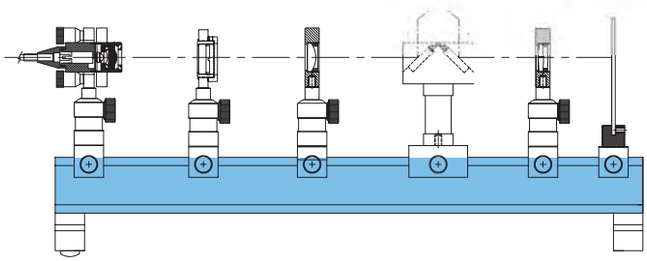
A refractometer is a laboratory device used for the measurement of 'index of refraction'. This refractometer utilizes the concepts of critical angle and total internal reflection to measure the refractive index of samples.

REFRACTOMETER - Related Topics
- Index of refraction
- Reflection by dove prism
- Total Internal reflection
- Dispersion
- Shadow Line

Experiment Example:

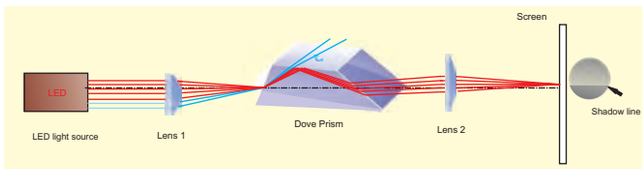
- **To find the refractive index of an unknown solution**

In this experiment, the sample is placed on the dove prism. Dove prisms rotate an image without deviating beam in such a way that the image rotates at twice the angular rate of the prism. LED light of wavelength 589nm is collimated and directed to the interface between the prism and the solution. The light rays meet the interface at different angles. Some of these angles are larger than the critical angle of the interface so that light is totally reflected. For angles of incidence smaller than the critical angle, light is partially transmitted (i.e. lost). Thus a shadow (less luminescence) is created on the screen. The position of the shadow indicates the magnitude of the critical angle. Hence the refractive index can be obtained.



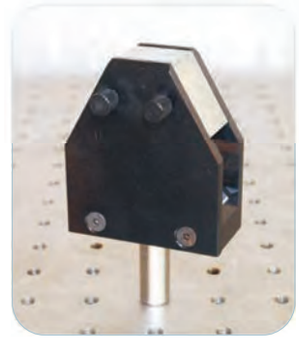
Measurement is performed on a sugar solution with known sugar concentration. Then the refractive index of a solution with an unknown concentration is measured. Through a comparison with the initial measurement, the unknown concentration can be deduced. In liquids and solids, the speed of light varies significantly with wavelength and the index of refraction . For the most accurate measurements it is necessary to use monochromatic light. Bright LED light is used here. Fine adjustments in grazing or incident angle can be done using kinematic tuning of the LED mount.

The lenses and dove prism are fixed on rail carriers which are held on graduated solid aluminum rail. All the mounts are made of anodized aluminum and can be mounted easily on the optical rail.



The index of refraction of the provided liquids are:

Water : 1.33
Acetone : 1.36
Sugar solution : 1.44



Dove Prism with Mount

Features:

- **Refractive index measurement is easy and efficient**
- **Compact and precision design**
- **High performance LED light source of optical wavelength 589nm**
- **Precise optics minimize aberrations**
- **Can observe clear and sharp shadow limits**
- **Mounts and rail with black anodized finish**

Scope of supply	Quantity
Optical rail (1000mm)	1 no.
Kinematic LED mount	1 no.
Dove prism with mount	1 no.
Plano convex Lens with mount.	2 nos.
White screen with graduated scale	1 no.
LED with variable power supply (589nm)	1 no.

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Mechanics is the branch of science that deals with the behavior of physical bodies when subjected to forces or displacements and their subsequent effect on their environment. In this section, we are introducing some products which helps to study various properties of solids, liquids and gases.

Contact Angle Meter 54
Model No: HO-ED-M-01

Young's Modulus Apparatus 55
Model No: HO-ED-M-02

Lee's Disc Apparatus
Model No: HO-ED-M-03 56

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Contact Angle Meter

Model No: HO-ED-M-01

Holmarc's Contact Angle Meter (Model No: HO-ED-M-01) is a compact and cost effective CCD based instrument for measuring contact angles of liquids over substrates. Contact angle is the angle formed by a liquid at the phase boundary where a liquid, gas and solid intersect. The shape of the drop is controlled by the three forces of interfacial tension. The shape of a liquid droplet on a flat horizontal solid surface is determined by the Young-Laplace equation. Image Analysis software is used for measurement and further calculations.

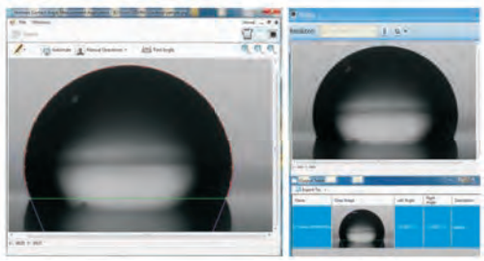
The instrument makes use of a CCD sensor to form the image of the droplet. The CCD sensor inputs images and live video to a computer for further analysis.

CONTACT ANGLE METER- Related Topics

- Thermodynamic equilibrium
- Young - Laplace equation
- Surface tension

Experiment Example:

- To measure the contact angle of liquids over various solids.



Manual dispensing syringe pump is used for liquid dispensing. The CCD sensor and imaging optical assembly are mounted on a translation stage for fine adjustment of image position on the sensor. The dispensing system which consists of a syringe along with linear stage is held on a vertical translator for initial setting of the distance of the needle from the solid surface. Back light is provided by bright LED. The illumination intensity of the back light LED can be controlled.

Specification:

Measuring method	Sessile drop method
Analysis method	Dropsnake analysis which is based on B-spline snakes (active contours) to shape the drop. Software can be used for measuring contact angles of both symmetrical and asymmetrical drops.
Optics	High performance aberration corrected imaging lens with precise manual focus adjustment.
Video system	High performance CCD Sensor. 3m shielded USB cable included.
Lighting	LED based diffused lighting mechanism. Light intensity can be varied.
Dispenser	Mechanical and motorized dispenser. 50,100 & 250 micro liter syringes provided with the system.
Dimension	500 x 400 x 498 mm
Power supply	230VAC, 50 Hz.
Other specifications	+/- 180 degree rotation provided for the sample holder. 75mm XY travel provided for the CCD - optics assembly.

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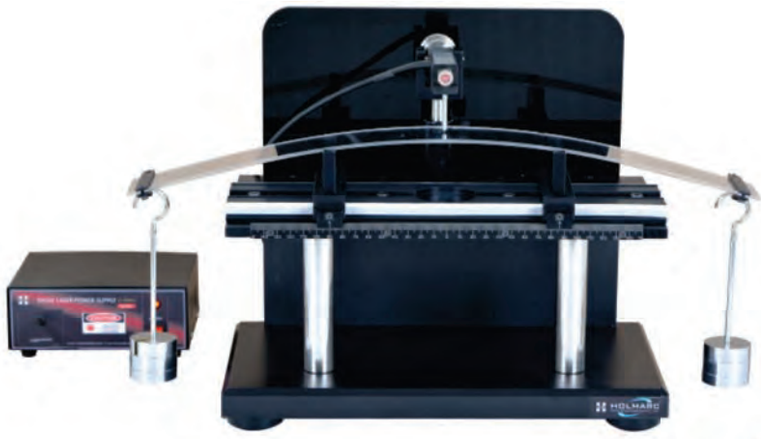
Young's Modulus Apparatus

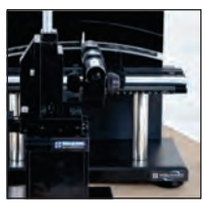
Model No: HO-ED-M-02

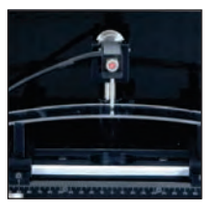


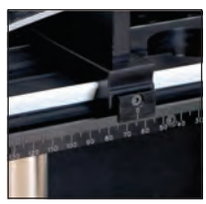
Holmarc's Young's modulus apparatus (Model No: HO-ED-M-02)is used to measure the Young's modulus of a bar. Young's modulus is a measure of stiffness of an elastic material and is a quantity used to characterize materials. It can vary considerably depending on the exact composition of the material. If the beam is loaded at its mid-point, the depression produced will not form an arc of a circle. This type of bending is called non-uniform bending. If the beam is loaded at both ends, the elevation produced will form an arc of a circle. This type of bending is called uniform bending. Two methods are used to measure Young's modulus of the bar in both uniform and non-uniform bending. They are Pin and Microscope method and Optic lever method.

Experiment Example:

- To find the Young's modulus of the material of a bar by uniform and non uniform bending using
  - Pin and microscope method
  - Optic Lever Method

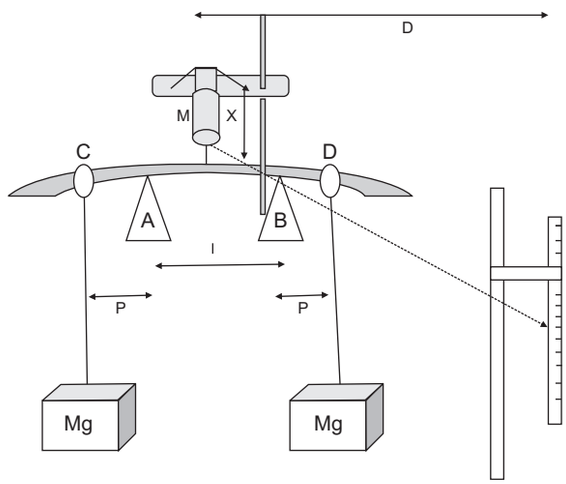




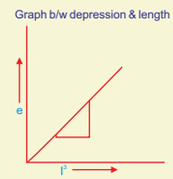


YOUNG'S MODULUS APPARATUS- Related Topics

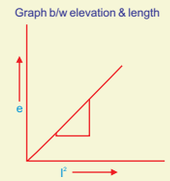
- Young's modulus
- Depression
- Elevation
- Bending –uniform and non uniform



In non uniform bending, the beam(meter scale) is supported symmetrically on two knife edges and loaded at its centre. The maximum depression is produced at its centre. Since the load is applied only at a point of the beam, this bending is not uniform through out the beam and the bending of the beam is called non- uniform bending.



In uniform bending,the bar is placed symmetrically on two knife edges. Two weight hangers are suspended at equal distance from the knife edges.Weights are added one by one and corresponding readings are taken. From these readings, the mean elevation (e) of the mid-point of the bar for a given mass is determined.



Scope of supply	Quantity
Young's modulus test bench	1 no.
Travelling microscope (10X magnification)	1 no.
Weight hangers with weights(100gm & 50 gm)	2 set each.
Meter scale with rigid base	1 no.
Laser line generator with power supply	1 no.
Sample test plates(Brass, Aluminium, Stainless steel,PMMA)	1 no each.

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Lee's Disc Apparatus

Model No: HO-ED-M-03

Holmarc's Lee's Disc Apparatus (Model : HO-ED-M-03) is designed for the measurement of thermal conductivity in bad conductors. Thermal conductivity is the property of a material that indicates its ability to conduct heat. Conduction takes place if there exists a temperature gradient in a solid (or stationary fluid) medium.

Energy is transferred from more energetic to less energetic molecules when neighboring molecules collide. Conductive heat flow occurs in the direction of the decreasing temperature because higher temperature is associated with higher molecular energy.

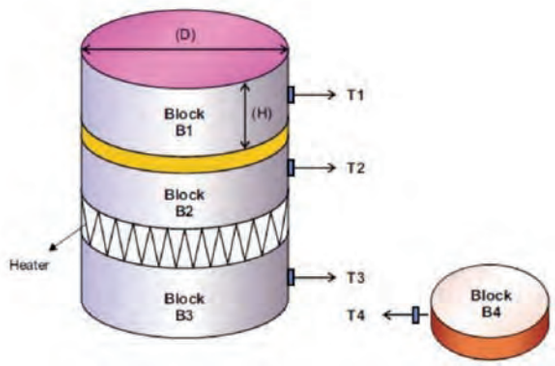
Lee's Disc Apparatus comprises of a brass disc resting on another slab of the same dimension with special heating coil. Both metallic discs have radial holes for the sensitive thermistors. Material under test is placed in between two discs. The heater is turned on and the apparatus is left idle until the temperature gets stabilized. At this point the heat energy passing through the heat sample will be exactly equal to the heat flowing out of the lower block.

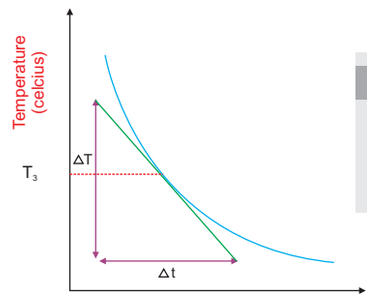
Maximum temperature the disc can achieve during the experiment is around 50 degree Celsius to make it safe for handling with even bare hands. Similarly, operating voltage for heating coil sandwiched between the discs is fixed as 50 V for safety. The temperature sensors used are highly sensitive and accurate with least count as low as 0.2 degree Celsius. Front panel is equipped with digital display and keyboard for user friendly operation.

This Apparatus provides the facility for performing experiments using different kinds of sample materials. The front panel includes LCD display and keyboard for readouts and settings.

Experiment Example:

- **To determine thermal conductivity of bad conductors(Glass, Nylon, Plywood, etc.)in the form of a disc using Lee's method.**





LEE'S DISC APPARATUS- Related Topics

- Thermal conductivity
- Heat transfer
- Specific heat capacity

Features:

- **New and integrated design**
- **Different samples can be tested**
- **LCD display is provided for accurate measurement**
- **Manual mode, auto mode and PC mode are possible**
- **User friendly equipment**

Scope of supply	Quantity
Lees disc control unit (230V 5Amp AC)	1 no.
Heating unit with disc (Manual mode 50V)	1 no.
Brass disc (Dia 76.2 mm)	2 no.
AC power code (Type 3 core 3 Pin)	1 no.
RS 232 PC cable (Length 5 meters)	1 no.
Test samples (Borofloat glass,Teflon, Plywood)	1 no each

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There are a wide variety of well-known effects related to electricity such as lightning, static electricity, electromagnetic induction and flow of electrical current. Different materials are influenced differently by the presence of a magnetic field. In this section, we are introducing some equipments to study various properties of electricity and magnetism.

Millikan's Oil drop Apparatus 57
Model No: HO-ED-EM-01

Apparatus for the Study of Photo Electric Effect (Planck's Constant) 58
Model No: HO-ED-EM-02

e/m Experiment Apparatus – Thomson's Method 59
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Franck-Hertz Experiment Apparatus 60
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Apparatus for the Study of Biot- Savart's Law 61
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Hall Effect Apparatus 62
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Magnetic Susceptibility – Gouy's Method 64
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Millikan's Oil Drop Apparatus

Model No: HO-ED-EM-01

Holmarc's Millikan oil drop apparatus (Model No: HO-ED-EM-01) is modernized version of classic set-up used to find out electron charge. The apparatus makes use of CCD camera along with computer screen for convenient viewing of oil droplet. Measurements of the droplets are also taken from display screen using a software module. Control of high voltage power supply across the electrode is made easy by having a digital display on the front panel.

MILLIKAN OIL DROP APPARATUS - Related Topics

- Electric charge
- Air buoyancy
- Air viscosity

Experiment Example:

- **To determine the charge of an electron by Millikan's Oil Drop Method**

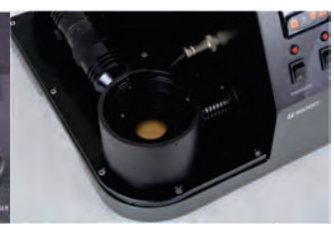
The apparatus consists of two horizontal metal discs placed 10mm apart in a closed chamber. Non-volatile oils are used for the experiment. A bright LED is used for illuminating the droplets inside the chamber in order to get a clear view.

SPECIFICATION

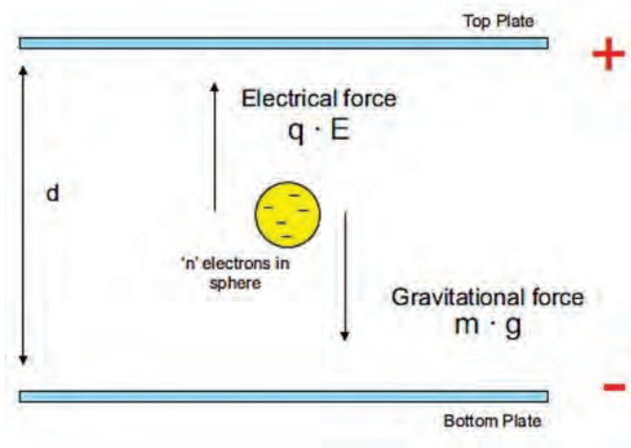
Power supply	230V AC, 50 Hz
Power cord	3 core 3 pin
Operating voltage	0-2KV
Video system	High performance CCD sensor
Camera lens magnification	30X
Lighting	High bright LED lighting mechanism
Optical power	1W
Dimension	590 x 490 x 760 mm

Features:

- **High resolution camera delivers clear view of oil droplet**
- **Holmarc's user friendly software system helps to monitor and measure the parameters of droplet movement.**
- **Light can be controlled to illuminate the droplets inside the chamber.**
- **Atomizer helps to spray tiny oil droplets.**



The significant difference in our setup is in the imaging system used for the observation of droplet movement. We use USB 2.0 camera which can be directly connected to the PC to monitor the droplet movement and can measure the velocity of the droplet with the help of Holmarc's dedicated software. This makes the measurements much easier and eliminates the need for conventional telescope and stopwatch system. A variable power supply of 0-2KV is used for conducting the experiment. The temperature inside the drop viewing chamber can be monitored through the front panel display system.



Scope of supply	Quantity
Oil drop control unit(0-2 KV)	1 no.
Droplet chamber	1 no.
Top charging plate	1 no.
CCD camera	1 no.
Camera lens assembly(Magnification 30X)	1 no.
LED Illumination unit(589nm/1 Watt)	1 no.
Atomizer	1 no.

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Apparatus for the Study of Photo Electric Effect (Planck's constant)

Model No: HO-ED-EM-02

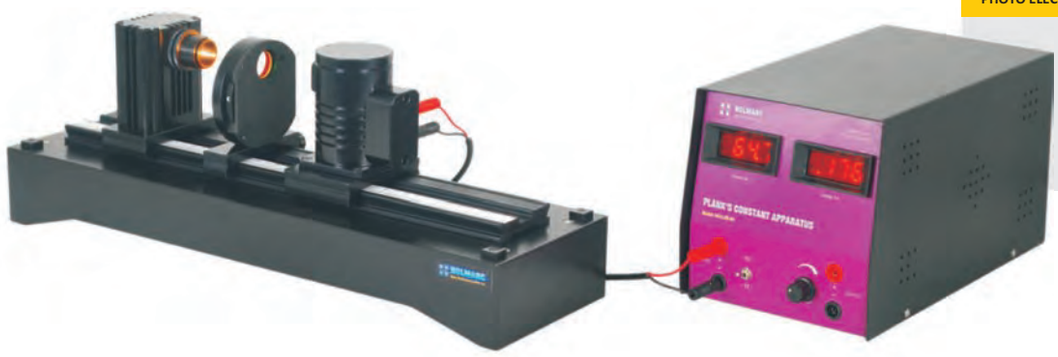


PHOTO ELECTRIC EFFECT APPARATUS - Related Topics

- Photoelectric effect
- Work function
- Absorption
- Photon energy
- Planck's constant

Holmarc's Photo Electric Apparatus (Model No: HO-ED-EM-02) is an instrument for studying the Photo Electric Effect and to obtain the Planck's constant.

A halogen source provides light energy to the photo tube. A filter wheel is placed in between the light source and photo tube to select different wavelengths. The filter wheel includes five narrow band interference filters to get the precise wavelength. A vacuum photo tube is kept inside the tube housing. This tube has very low anode dark current to achieve better results. The microprocessor controlled electronic interface gives the current and voltage readouts. The regulated power supply has 0 - 2V variable voltage to provide the stopping potential for electrodes. The ammeter gives accurate current output measurement facility. Toggle switch is provided to change the current range. The lamp house, filter wheel and photo tube housing are placed on an optical rail.

Features:

- The current amplifier is configured with high sensitivity and stability to improve the accuracy of measurement .
- The optical filters are of high quality in order to reduce the error while selecting the wavelength.
- The photo tube has low levels of dark current and anode reverse current.

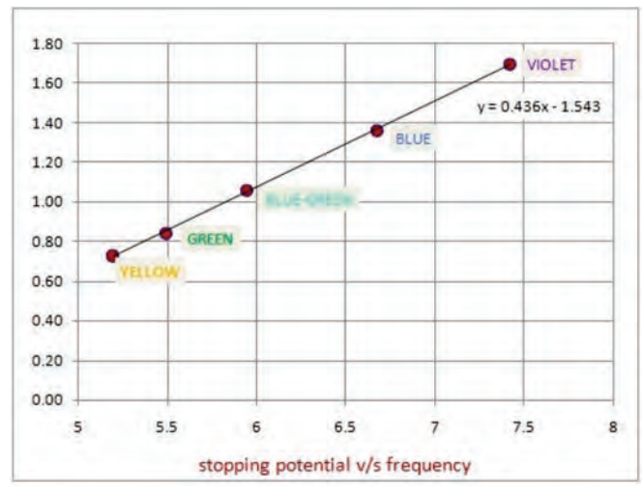
Photo electric effect is the liberation of electrons from the surface of a material by absorption of energy from incident light. For each metal, there exists a minimum binding energy for electron, which is a characteristic of the element, called the work function .When a photon strikes a bound electron, it transfers its energy to the electron. If this energy is less than the metal's work function, the photon is remitted and no electrons are liberated. If this energy is greater than an electron's binding energy, the electron escapes from the metal with a kinetic energy equal to the difference between the photon's original energy and the electron's binding energy.

Scope of supply — Quantity

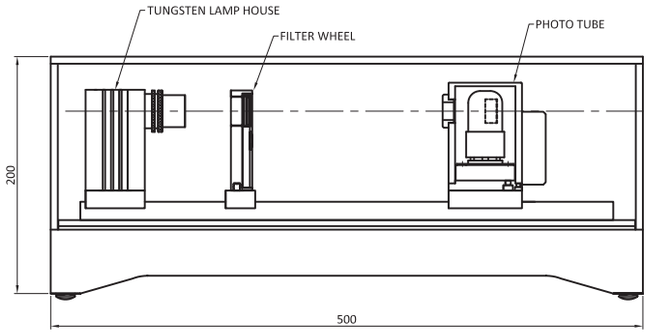
Rail based platform(Length 500mm)	1 no.
Filter wheel with 5 Interference filters	1 no.
Tungsten halogen lamp with mount(20 W)	1 no.
Vacuum photo tube with mount	1 no.
Photo electric effect control unit(0 - 2 V)	1 no.
Acrylic dust protective cover	1 no.

Experiment Examples:

- Determination of Planck's constant
- Determination of work function of the material



The stopping potential is measured by varying the anode voltage until the current drops to zero. The slope of a plot of stopping potential versus frequency is the value of the ratio, h/e. Hence the value of Planck's constant (h) and work function of the material can be determined. This instrument also imparts students, fundamental understanding of the quantum nature of light.



e/m Experiment Apparatus (Thomson's method)

Model No: HO-ED-EM-03

Holmarc's e/m apparatus (Model No: HO-ED-EM-03) is designed for the measurement of the charge to mass ratio e/m, of the electron. This equipment also facilitates the demonstration of effects of electric and magnetic fields on a moving charged particle. It consists of a fine beam electron tube known as e/m tube, a pair of Helmholtz coils and the electronic control box. The e/m tube consists of a filament as cathode, an accelerating anode and a pair of deflection plates. The heater heats the cathode, which emits electrons. The electrons are accelerated by the potential applied between the cathode and the anode.

The grid is held positive with respect to the cathode and negative with respect to the anode. The tube is filled with helium at low pressure. The electron tube is placed between a pair of Helmholtz coils.

Experiment Example:

- To measure the Charge to Mass ratio of Electron (e/m)

The electronic control unit provides the energy requirements for the tube and Helmholtz coil. The Helmholtz coil is a pair of coils separated by a distance of the coil radius. The e/m tube generates a fine electron beam by applying accelerating voltage. Electron collisions with the gas molecules excite the gas molecules and produce light emission in a cylindrical sheath around the electron beam. As the excited molecules relax, the electron paths become visible.

This e/m apparatus is also used for demonstration of electron beam deflection using the deflection plates. When we apply current to the Helmholtz coil, uniform magnetic field is generated and as a result, the fine electron beam changes its path to circular. By measuring the accelerating potential (V), the current through the Helmholtz coils (I) and the radius of the circular electron beam(r) we can find out the electron-mass ratio.

e/m EXPERIMENT APPARATUS - Related Topics

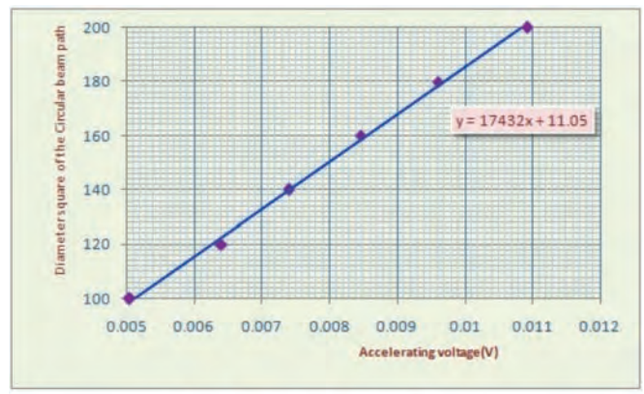
- e/m Ratio
- Helmholtz coil
- Lorentz force
- Cathode
- Anode

SPECIFICATION

Accelerating voltage	0-250V DC
Coil current	0.5-2.5A, reversible
Deflection plate voltage	50-250V, reversible
Display	Two row LCD display
Power input	230VAC 50Hz

Features:

- Excellent for accurate measurements of charge-to-mass ratio
- Clear observation of circular electron beam path
- Change in direction of the coil current possible



Diameter square as a function of Voltage

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Franck Hertz Experiment Apparatus

Model No: HO-ED-EM-04

The Franck - Hertz Apparatus (Model No: HO-ED-EM-04) is designed for verifying the existence of quantized states. The instrument can, not only lead to a plot of the amplitude spectrum curve by means of point by point measurement, but also directly display the amplitude spectrum curve on the oscilloscope screen.

The Franck-Hertz experiment is a fundamental quantum physics experiment which confirmed the quantization of atomic energy levels. This experiment supports Bohr model of atom. Apparatus used for the experiment consist of a tube containing low pressure gas, fitted with four electrodes.

Experiment Examples:

- **To measure the excitation potential of Argon using the Franck- Hertz method.**
- **To verify that atomic systems have discrete energy levels by bombarding electrons and observing the difference in energy levels.**

When an electron has an inelastic collision with an argon atom, the kinetic energy lost to the atom causes one of the outer orbital electrons to be pushed up to the next higher energy level. This excited electron, within a very short time, falls back into the ground state level, emitting energy in the form of photons. The original bombarding electron is again accelerated toward the grid anode and this excitation energy can be measured.

FRANCK HERTZ EXPERIMENT - Related Topics

- Quantum energy
- Excitation energy
- Electron collision
- Inelastic collision

In the spectrum amplitude curve , the voltage difference between two consecutive peak point is the first excitation potential of argon atom. This experiment illustrates the fact that the electrons in the Franck Hertz tube collide with argon atoms and excite the atoms from low level to high level. By measuring the argon's first excitation potential we can verify that the energy absorbed and transmitted is discrete, not continuous.

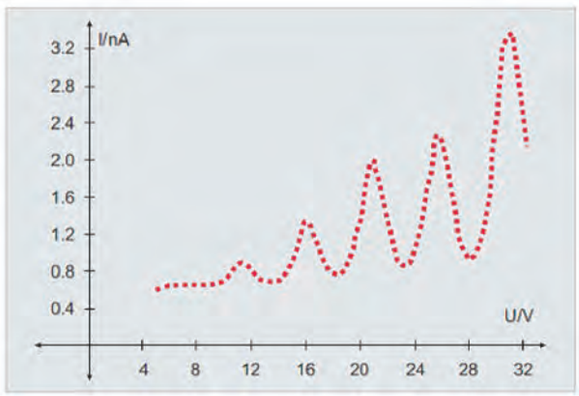
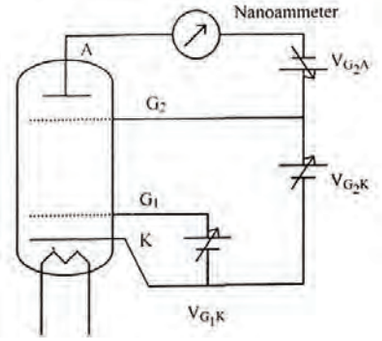


Fig.Current Measurements in the Frank-Hertz Experiment

The four electrodes are: an indirectly heated, oxide coated, cathode as an electron source, two grids G_1 and G_2 and a plate A, which serves as an electron collector. In this experiment, the electron beam is produced by thermionic emission from a filament. The electrons are accelerated, passed through the vapour, and are then retarded (decelerated) by a few volts before collection at the anode. All these takes place in an argon filled tube.

SPECIFICATION

Franck-Hertz Tube	Argon Filled Tetrode
Power Supply Unit	
V_{G1K}	1.20 – 5.00 V (continuously variable)
V_{G2K}	0.00 – 95.00 V (continuously variable)
V_{G2A}	1.30 - 14.50 V (continuously variable)
Filament Voltage	2.8 -3.40V (continuously variable)
Saw tooth waveform for CRO display	
Scanning Voltage	0-90V
Scanning Frequency	18 ± 2Hz
Input Power	230V/50Hz



Apparatus for the study of Biot-Savart's Law

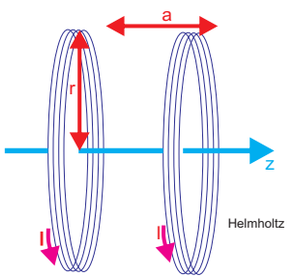
Model No: HO-ED-EM-05

Holmarc's Apparatus Model No: HO-ED-EM-05 has been designed for the study of Biot - Savart's law. This law can be applied practically to calculate the magnetic field produced by an arbitrary current distribution. It gives fundamental quantitative relationship between an electric current and the magnetic field it produces. The law is also valid for a current consisting of charges flowing through space.

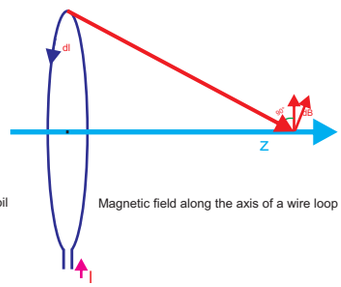
The magnetic field along the axis of wire loops and coils of different dimensions is measured using a Gauss meter. The relationship between the maximum field strength and the dimension is investigated and a comparison is made between the measured and the theoretical effects of position. The Gauss meter probe is mounted on a rail with a scale. It can be moved smoothly and precisely for measurement of magnetic field along the center of the coils. In general, any current loop has a magnetic field and thus has a magnetic dipole moment. This helps to explain why some materials exhibit strong magnetic properties.

Experiment Examples:

- To study the variation of magnetic field due to Helmholtz coil and single coil carrying current.
- To determine the magnetic field constant
- To measure the magnetic flux density in the middle of various wire loops using the gauss meter.



Helmholtz Coil



Magnetic field along the axis of a wire loop

BIOT-SAVART'S LAW - Related Topics

- Biot - Savart's law
- Helmholtz coils
- Magnetic moment
- Magnetic flux density
- Single coils

Helmholtz Coil

The Helmholtz Coil consists of two coils that have the same radius and mounted on a base to provide a uniform magnetic field between the coils. The base has a slot that allows the coils to be spaced apart at any distance from 3 cm to 20 cm (center-to-center distance). The separation for Helmholtz coils is marked on the base.

Single Coil

For a single coil of radius r with N turns carrying current I, the magnetic field due to the coil at a distance x along the axis passing through the center of the coil and perpendicular to its plane can be calculated using the Biot - Savart Law . Magnetic field value is measured for different currents.

Features:

- Digital Gauss meter gives a direct reading of magnetic field.
- Center to center distance of the Helmholtz coil can be varied.
- Precise and accurate measurements.
- Gauss probe holder offers excellent rigidity and positioning accuracy
- Specially designed modular set up.

Scope of supply	Quantity
Helmholtz coil	1 no.
Circular coil	3 nos.
Constant current power supply	1 no.
Digital gauss meter	1 no.
Gauss probe holder	1 no.

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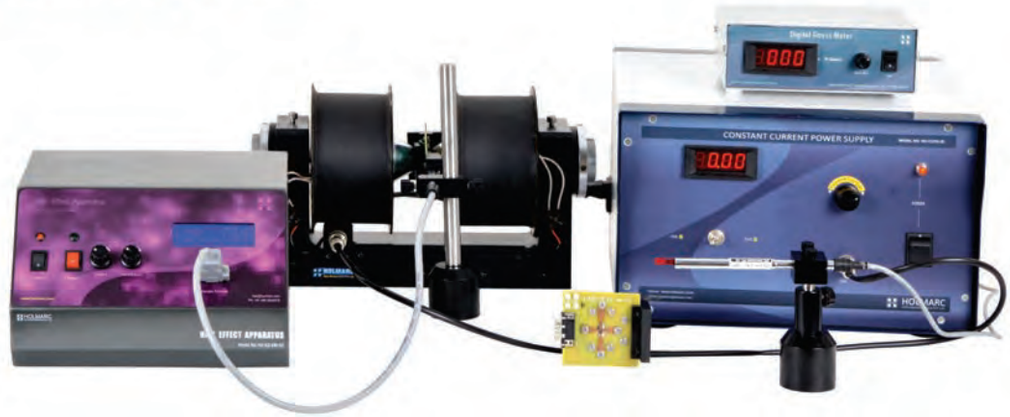
Hall effect Apparatus

Model No: HO-ED-EM-06



Holmarc's Hall Effect apparatus (Model no: HO-ED-EM-06) is designed with state of the art modules and components. Digital display is used for all value read outs. Electro-magnets, gauss meter, power supply, etc. are designed and made as separate modules for students to understand the apparatus and the principles involved easily. Safety is given due consideration in the design of the apparatus

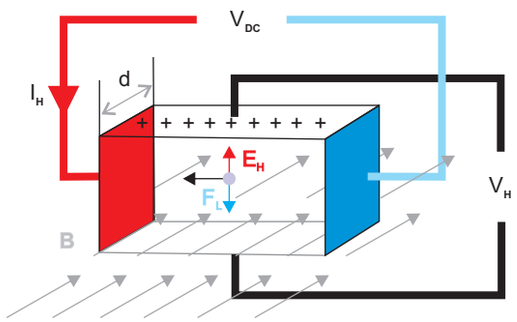
Experiment Examples:

- Measurement of Hall voltage as a function of
  - a. Magnetic flux density
  - b. Sample temperature
  - c. Sample current
  - for n and p-doped germanium crystals.
- Determination of density and mobility of charge carriers
- Determination of Hall coefficient of semi conductor crystals

HALL EFFECT APPARATUS - Related Topics

- N-type and p-type semiconductors
- Hall co-efficient
- Hall voltage
- Carrier density
- Carrier mobility
- Magnetic flux density

The system consists of two cartridges, each of which is equipped with 'p' and 'n' doped germanium crystal .The cartridges can be plugged easily and safely into the D connector system. The Hall Effect set up provides all operating parameters for the samples and displays the Hall voltage, sample current as well as the sample temperature. The doped Germanium samples are used to measure the Hall-voltage as a function of the sample current, the magnetic flux density and the sample temperature.



The Hall voltage is caused by the deflection of the moving charge carriers in the magnetic field due to the Lorentz force, of which, direction can be predicted by the right hand rule. The sign of the Hall coefficient is determined by the polarity of the charge carriers: a negative sign implies carriers with a negative charge ("normal Hall effect"), and a positive sign indicates carriers with a positive charge ("anomalous Hall effect"). The Hall coefficient depends on the material and the temperature.

Hall effect cartridge

SPECIFICATION

Hall Current	0 - 10 mA
Hall Voltage	0 - 200 mV
Temperature	Ambient - 50°C
Crystal	n-type and p-type lightly doped Germanium (Ge)
Field density	0 - 5 ±5% KG

Scope of supply	Quantity
Hall effect control unit	1 no.
Sample control holder with rigid base	1 no.
Gauss probe holder with mount	1 no.
Digital gauss meter(Range 0 - 20K gauss)	1 no.
Hall effect cartridge(n type & p type)	1 no each.
Electromagnet	1 no.
Constant current power supply (0 - 3.5 A)	1 no.

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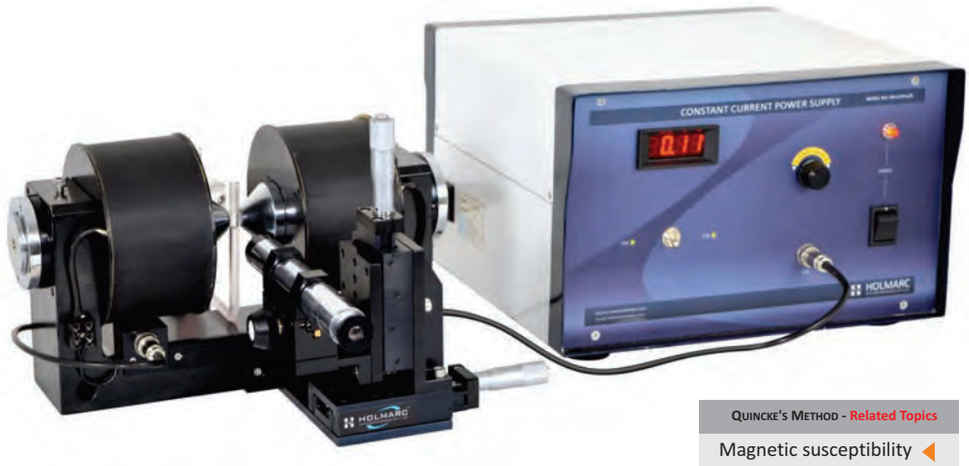
Fax : +91 484 2540882

Magnetic Susceptibility- Quincke's Method

Model No: HO-ED-EM-07

Holmarc's Magnetic Susceptibility - Quincke's Method Apparatus (Model No: HO-ED-EM-07) is designed for the determination of magnetic susceptibility of a given solution. The apparatus consists of a pair of electromagnets and a Quincke's tube in which the sample is taken. This tube is U shaped and has two limbs, one with very narrow width compared to the other. So, the change in the level of the liquid in the narrow limb does not affect the level in the wider limb. The magnetic field is measured using a digital Gauss meter. In Holmarc's apparatus, the rise in liquid by the application of magnetic field is measured using a traveling microscope.

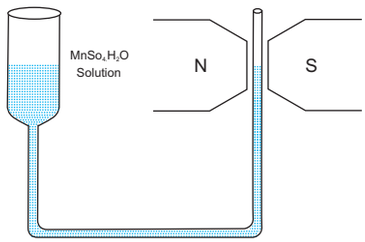


QUINCKE'S METHOD - Related Topics

- Magnetic susceptibility
- Magnetization
- Relative permeability

Experiment Examples:

- Calibration of the magnetic field
- Measurement of magnetic susceptibility of paramagnetic Solutions

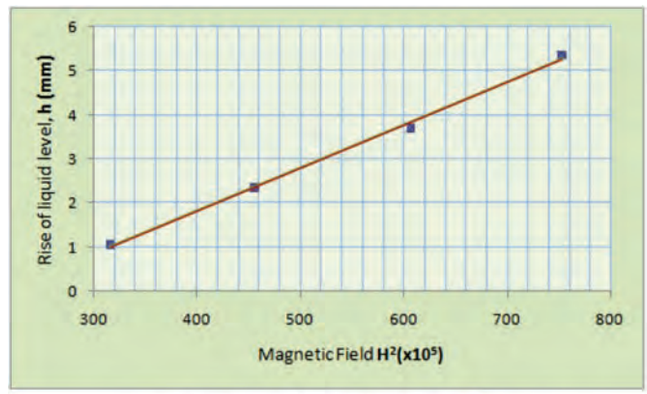


On applying magnetic field, the liquid in the Quincke's tube either rise or fall. If the liquid is paramagnetic with respect to the surrounding air , the liquid level will rise and if it is diamagnetic, then the liquid level will fall. In this apparatus, paramagnetic liquid is used and the liquid level will rise.

Features:

- Precise and accurate measurements
- Superior image quality of traveling microscope with precision micrometer drive
- Digital gauss meter gives direct reading of magnetic field in the 0-20 KG range

The Quincke's Method is used to determine magnetic susceptibility of paramagnetic substance in the form of a liquid or an aqueous solution. This method is based on the force experienced by a magnetized material in a non-uniform magnetic field. When an object is placed in a magnetic field, a magnetic moment is induced in it. The magnetic susceptibility is a proportionality constant which is dimensionless and indicates the degree of magnetization of a material in response to an applied magnetic field. A liquid sample in a narrow tube placed between the poles of a magnet experiences a force and hence when the field is turned on, the meniscus in the narrow tube rises by an amount h, relative to its zero-field position. Measuring this rise enables to determine the susceptibility of the solution.



Variation of liquid level w.r.t Magnetic field

Scope of supply	Quantity
Electromagnet(1 Telsa)	1 no.
Constant current power supply (0-3.5 A)	1 no.
Digital gauss meter (Range 0-20 KG)	1 no.
Quincke's tube with stand	1 no.
Gauss probe mount	1 no.
Travelling microscope (Magnification 10X)	1 no.

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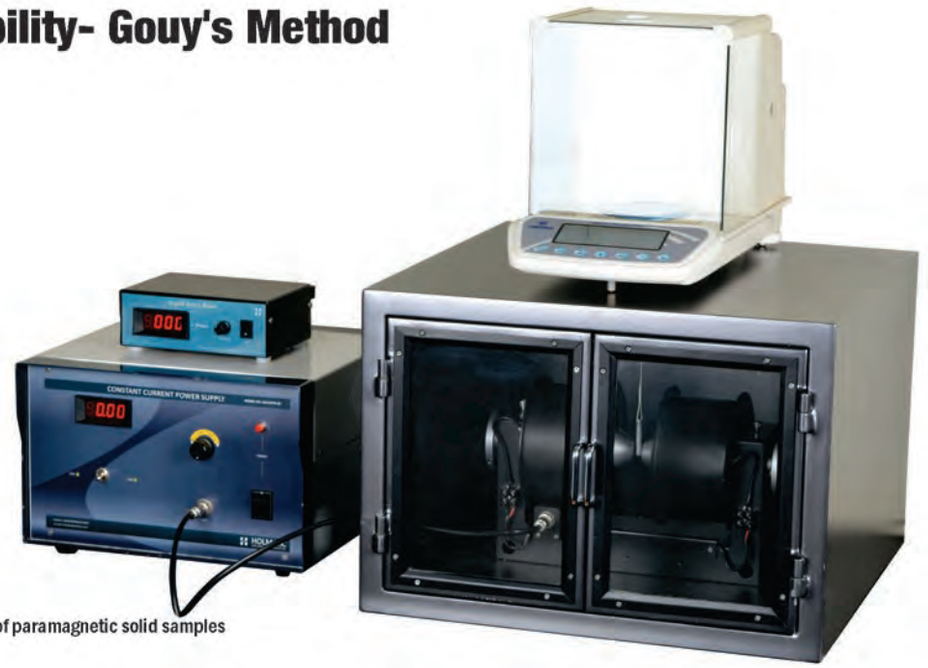
Magnetic Susceptibility- Gouy's Method

Model No: HO-ED-EM-08

Holmarc's Magnetic Susceptibility - Gouy's Method Apparatus (Model No: HO-ED-EM-08) is designed for the determination of magnetic susceptibility of solid samples. The apparatus consists of a pair of electromagnets with constant current power supply and a tube in which the sample powder is taken. The magnetic field is measured using a digital Gauss meter. The sample weight measurements are taken with the help of a Gouy balance.



Experiment Examples:

- Calibration of the magnetic field
- Measurement of Magnetic Susceptibility of paramagnetic solid samples

In the Gouy's method of susceptibility measurement, the solid sample in the form of a long cylinder is hung from the pan of a balance and is placed in such a way that one end of the sample is between the pole pieces of the magnet and the other one is outside the field. The force exerted on the sample by the inhomogeneous magnetic field is obtained by measuring the apparent gain or loss in sample weight.

GOUY'S METHOD - Related Topics

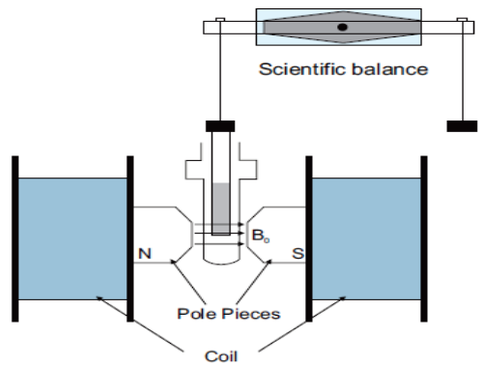
- Magnetic susceptibility
- Gouy's method
- Magnetization
- Relative permeability

A sample with a para magnetic compound will be pulled down towards the magnet and will provide a positive difference in apparent mass. Diamagnetic compounds can either exhibit no apparent change in weight or a negative change, as the sample is slightly repelled by the applied magnetic field. With a para magnetic sample, the magnetic induction is stronger than the applied field and magnetic susceptibility is positive. A diamagnetic sample has a magnetic induction much weaker than the applied field, and a respective negative magnetic susceptibility.

Material	Magnetic Susceptibility x 10^{-5} ($cm^3 \cdot mol^{-1}$)
Tungsten	6.8
Cesium	5.1
Aluminum	2.2
Lithium	1.4
Magnesium	1.2
Sodium	0.72

Table: Magnetic susceptibility of some materials

The Gouy balance measures the apparent change in the mass of the sample as it is repelled or attracted by the region of high magnetic field between the poles. The sample is suspended between the magnetic poles through an attached string. The experimental procedure requires two separate reading to be performed. An initial balance reading is performed on the sample of interest without a magnetic field. A subsequent balance reading is taken with an applied magnetic field. The apparent change in mass from the two balance readings is the result of magnetic force on the sample.



Scope of supply	Quantity
Electromagnet	1 no.
Constant current power supply (0-3.5 A)	1 no.
Digital gauss meter (Range 0-20 KG)	1 no.
Glass tube with stand	2 nos.
Gauss probe mount	1 no.
Gouy's balance	1 no.
Specimen holder with mount	1 no.

LASER **Raman** Spectrometer

Model : HRRS 216R2

Research Grade Raman Spectrometer for quick identification of a variety of liquid, solid and powder samples

Excitation Sources
532 & 785nm

NEW

Raman Spectrometer
Model : HRRS 216R2

Raman System Features

Configurable Wavelengths

- Computer-controlled, user-friendly interface.
- Save your samples and can search for matches.
- DPSS 532nm laser source.
- Both solid and liquid samples can be analyzed.
- -30 Degree Cooled CCD Sensor for low light measurements

Holmarc's new series of cooled CCD spectrometers configured for Raman spectroscopy applications perform quick identification of a variety of liquid, solid and powder samples.

It has been developed to meet the needs of Material Science, Manufacturing and Biochemistry incorporating high quality optical system which can be fully customized for using with fiber-optic probes or an optional microscope with spatial resolution down to 20 μm. Spectra Software simplifies data collection and analysis. Software features library searching and sample database creation.

This spectrometer is designed for recording Raman emissions from solids as well as liquids when a laser beam is passed trough the sample. The apparatus suits Chemistry as well as Physics labs for characterizing materials by recording Raman emissions. The set up consists of 200mW DPSS 532nm laser with variable power controlling option, collection optics, sample mount, stages, monochromator and cooled CCD camera.

The measurements are done by selective scanning method providing full spectral collection of Raman data at high spectral resolution.. Spectrometer records intensity of each interested wavelength range using cooled CCD camera. The readings are plotted on a graph. Spectrometer used in the system has high resolution and low stray light. Electronics hardware is made integrated for spectrometer, detector and laser source so that fully automatic operation is possible from interfaced computer.

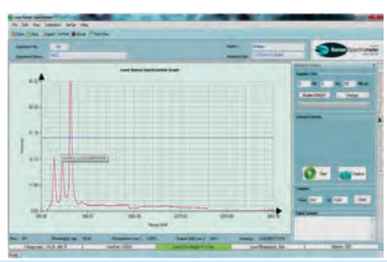


Fig. HOLMARC Spectra RA software

Optical system

High resolution, high stability and low stray light 300F CT configured CCD spectrometer with selective scanning for different excitation source selection.

Spectrometer D/f	: 1/6
Grating	:1200L/mm
Entrance slit	: 0-2mm adjustable
Wavelength range	: 320-1050nm (Spectrometer)
Raman spectrum	: 200-4000cm^{-1}
Laser source	: DPSS 532nm low noise laser, 785nm laser (optional)
Output power	:>200mW variable power
Wavelength accuracy	: ±0.1cm
Wavelength repeatability	: ≤0.5cm
Resolution	: ≤2cm^{-1} at 532nm
Rayleigh filter	: 17nm bandwidth Notch filter
CCD detector	: High sensitive CCD detector 3648 element hermetically sealed vacuum cooled down to -30°C.
Signal to noise ratio	: 500:1
A/D Resolution	: 12/16 Bit
Exposure time	: 0.1 - 6500 ms
Optics mirrors	: Protective aluminium coated and aspherized achromatic lenses optimized for VIS-NIR range.
Objective lens	: Aspherized achromatic 0.45N.A objective lens with10mm W.D
Sample holder	: Accommodate standard 10mm cuvette, custom sample holders
Sample positioning	: XYZ micrometer with step resolution of 10 micron.

Acoustics is the branch of science that deals with the study of mechanical waves in gases, liquids and solids including vibration, sound, ultrasound and infrasound. Our products helps to understand the basic principles involved and to develop skill to conduct experiments independently. The application of acoustics is present in almost all aspects of modern society . The science of acoustics spreads across many facets of human society-music, medicine, architecture, industrial production, warfare and more.

Detector Based Apparatus for Ultrasonic Diffraction 66
Model No: HO-ED-A-01

Screen Based Apparatus for Ultrasonic Diffraction 67
Model No: HO-ED-A-01A

Kundt's Tube Apparatus 68
Model No: HO-ED-A-02

Impedance Tube Apparatus 69
Model No: HO-ED-A-03

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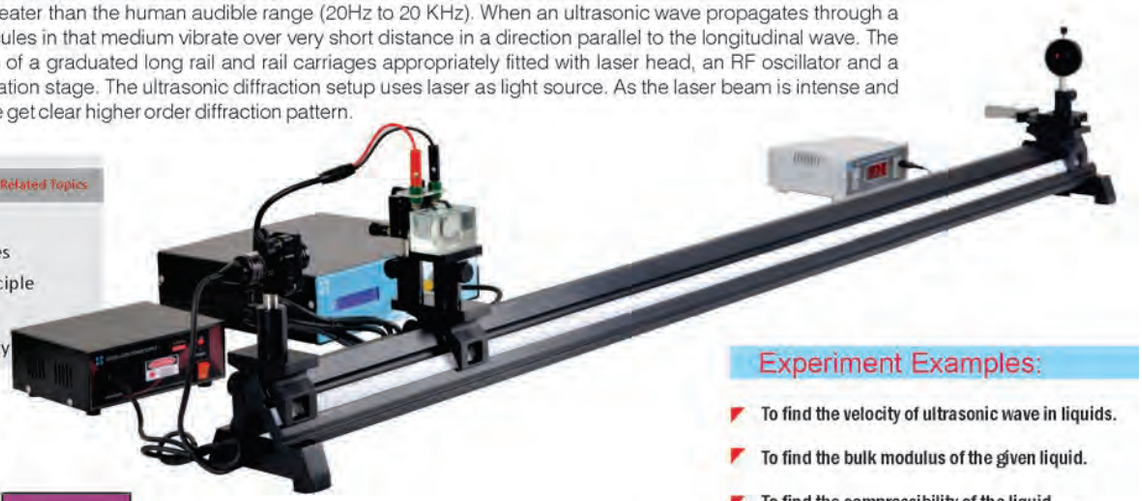
Detector Based Apparatus for Ultrasonic Diffraction-Acousto optic effect

Model No: HO-ED-A-01

The Ultrasonic diffraction apparatus is used to study diffraction of light by ultrasonic waves. Ultrasonic sound refers to sound with a frequency greater than the human audible range (20Hz to 20 KHz). When an ultrasonic wave propagates through a medium, the molecules in that medium vibrate over very short distance in a direction parallel to the longitudinal wave. The apparatus consists of a graduated long rail and rail carriages appropriately fitted with laser head, an RF oscillator and a detector with translation stage. The ultrasonic diffraction setup uses laser as light source. As the laser beam is intense and monochromatic, we get clear higher order diffraction pattern.



ACOUSTO-OPTIC EFFECT - Related Topics

- Interference
- Standing waves
- Huygens' Principle
- Bulk modulus
- Compressibility

Experiment Examples:

- To find the velocity of ultrasonic wave in liquids.
- To find the bulk modulus of the given liquid.
- To find the compressibility of the liquid.

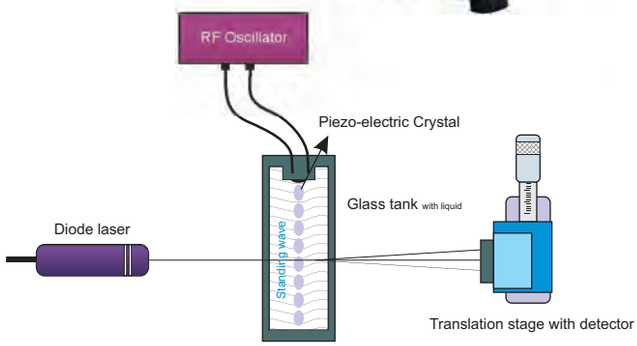
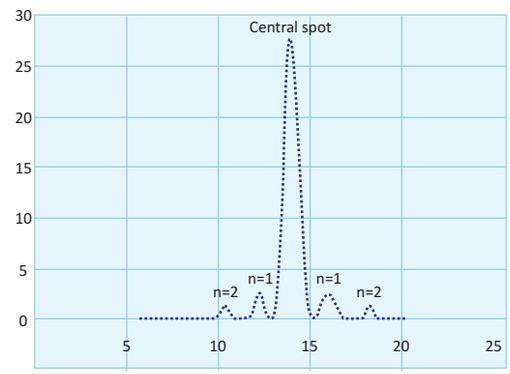


Fig. Optical system for observation of diffraction by ultrasonic waves

The ultrasonic waves generated by the transducer travels down the medium (liquid) and gets reflected at the bottom (flat glass plate) of the cell. The incident and reflected waves interfere and a stationary / standing wave pattern is formed. The laser head is mounted using a kinematic holder. This helps to direct the laser beam through the liquid and then to the detector conveniently. The diffraction pattern is scanned using a translation stage with freedom in X axis. The velocity of ultrasonic waves in liquids can be calculated from this experiment. This instrument is designed to give accurate and best results.



Graph shows distance Vs. detector current

Features:

- Precision design
- Diode laser is used as light source
- 5MHz ,3MHz crystals
- Corrosion free
- High quality photo detector

SPECIFICATION OF PIEZO ELECTRIC CRYSTALS

Dimension	20mm diameter x 0.7mm thickness
Resonant frequency f_r	3MHz ± 50 KHz
Resonant impedance Z_m	≤ 6 Ω.
Static capacitance Cs	5700pF±15% @ 1 kHz
Dimension	20mm diameter x 0.4mm thickness
Resonant frequency f_r	5MHz ± 100 KHz
Resonant impedance Z_m	≤ .48 Ω.
Static capacitance Cs	3800pF±20% @ 60 Hz/1V

Scope of supply	Quantity
Optical rail (1500 mm)	1 no.
Kinematic laser mount	1 no.
Glass tank mount with crystal holder	1 no.
Detector mount with X- translation (Micrometer controlled)	1 no.
Glass tank (Float)	2 no.
Piezo electric crystals (3 MHz,5 MHz)	1 no each.
RF Oscillator (Frequency range=2-6MHz)	1 no.
Diode laser with power supply (3 mW 650nm)	1 no.
Detector with output measurement unit	1 no.

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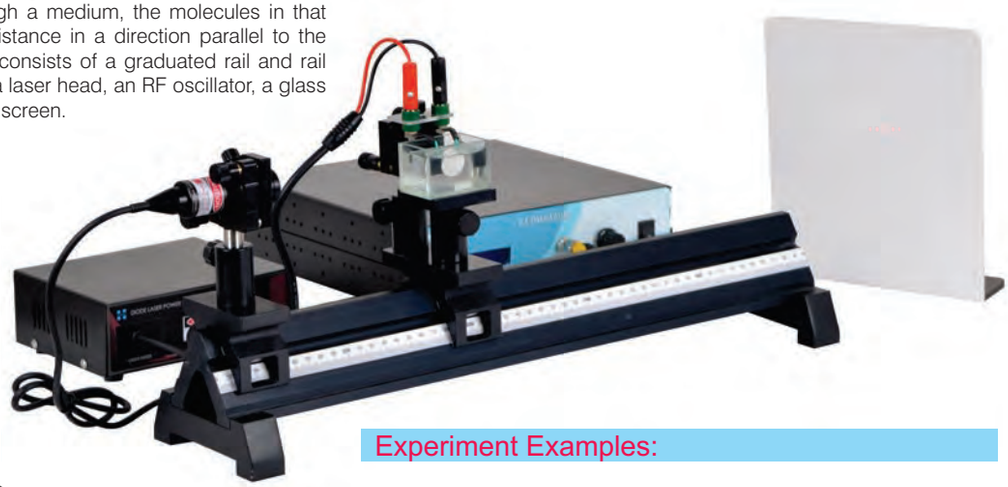
Screen Based Apparatus for Ultrasonic Diffraction-Acousto optic effect

Model No: HO-ED-A-01A

The Ultrasonic diffraction apparatus is used to study diffraction of light by ultrasonic waves. Ultrasonic sound refers to sound with a frequency greater than the human audible range (20Hz to 20 KHz). When an ultrasonic wave propagates through a medium, the molecules in that medium vibrate over very short distance in a direction parallel to the longitudinal wave. The apparatus consists of a graduated rail and rail carriages appropriately fitted with a laser head, an RF oscillator, a glass tank mount with crystal holder and a screen.

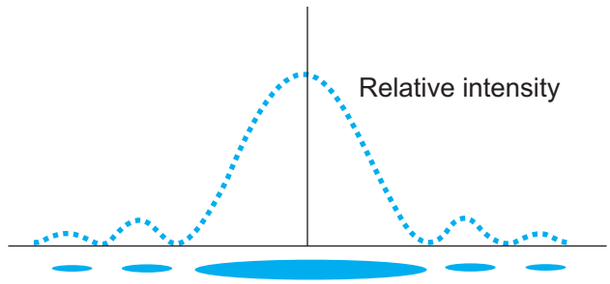


ACOUSTO-OPTIC EFFECT - Related Topics

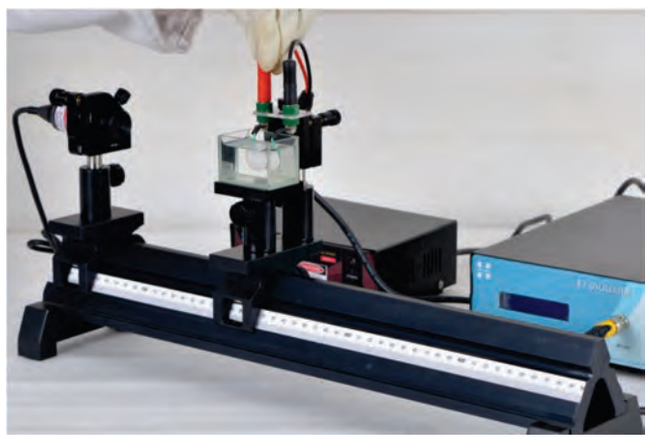
- Interference
- Standing waves
- Huygens' Principle
- Bulk modulus
- Compressibility

Features:

- Diode laser is used as light source
- Easy to operate and portable.
- 5MHz, 3MHz Piezo electric crystals.
- Corrosion free
- Precision design
- Extended durability



Pattern on the screen



Experiment Examples:

- To find the velocity of ultrasonic wave in liquids.
- To find the bulk modulus of the given liquid.
- To find the compressibility of the liquid.

The ultrasonic waves generated by the transducer travels down the medium (liquid)and gets reflected at the bottom (flat glass plate) of the cell. The incident and reflected waves interfere and a stationary / standing wave pattern is formed. The pattern can be observed on a screen or a wall and we can plot diffraction pattern on a graph paper for further calculations.

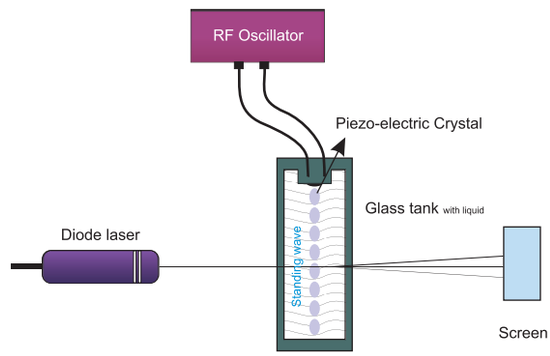


Fig. Optical system for observation of diffraction by ultrasonic waves

Scope of supply	Quantity
Optical rail (500 mm)	1 no.
Kinematic laser mount	1 no.
Glass tank mount with crystal holder	1 no.
Glass tank (Float)	2 no.
Piezo electric crystals (3 MHz,5 MHz)	1 no each.
RF Oscillator (Frequency range=2-6MHz)	1 no.
Diode laser with power supply (3mW, 650nm)	1 no.
Screen	1 no.

Kundt's Tube Apparatus

Model No: HO-ED-A-02

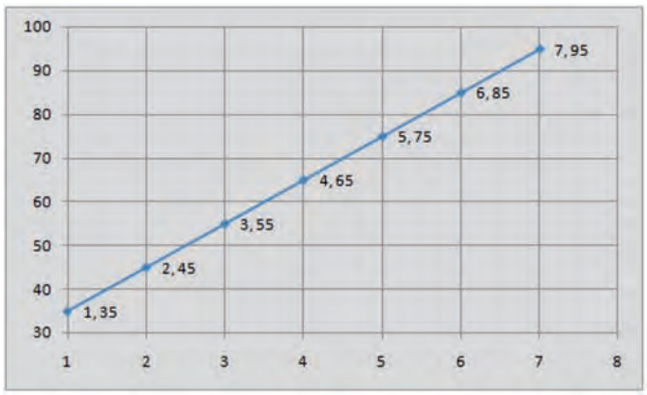
Holmarc's Kundt's tube apparatus (Model No: HO-ED-A-02) is a device for measuring the speed of sound. Any waves traveling along the medium will reflect back when they reach the end creating a standing wave allowing harmonics to be identified. Nodes occur at fixed ends and anti-nodes at open ends. Furthermore, it provides an insight into the interesting phenomenon of standing sound waves.

Features:

- The scale can be rotated and positioned (for measuring the microphone position).
- The parts can be easily removed from the tube and re-packed for storage in the classroom.
- The microphone is sensitive and strong
- The piston fits in the tube with close tolerance. The piston supporting rod is made of brass.

Experiment Examples:

- To find the velocity of sound in air with the help of head phone
- To find the velocity of sound in air using Lissajous Figures



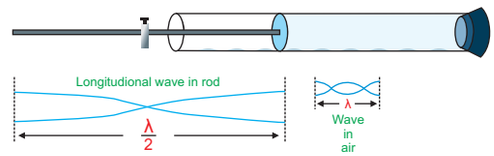
Graph shows microphone position Vs. Number of wave lengths

Scope of supply — Quantity

Kundt's tube with graduated scale (Length 1000mm)	1 no.
Speaker with sound sealing case	1 no.
Microphone with piston	1 no.
Head phone	1 no.
Speaker	1 no.
Kundt's tube control unit	1 no.

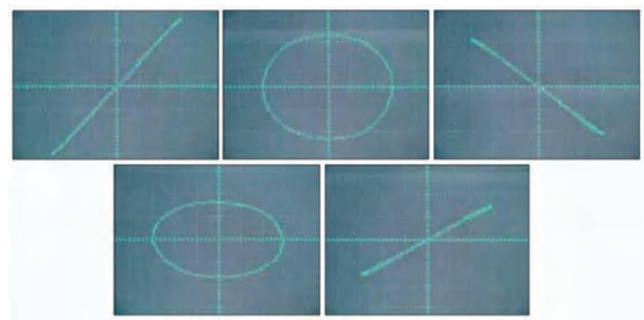
SPECIFICATION

- Transparent solid tube,59mm dia X 1000mm long
- End housing fixed with 2" speaker for creating the sound waves
- Piston on a long rod to create variable length closed tubes
- Driver unit to interface the microphone to an amplifier or oscilloscope.



In this experiment the amplitude of the sound wave can be observed at different locations in the tube, allowing a half wave length to be measured between an adjacent maximum and minimum.

Here, one-side closed cylindrical transparent pipe filled with air is used as a resonator. One end of the tube is attached with a loudspeaker where as the other end is fixed with a movable piston with reflector and a microphone. An AC voltage applied to the loudspeaker, tunes the membrane to vibrations that are transferred to the gas or air column. Frequency can be changed by enlargement or diminishment of the glass cylinder as well as by changing the frequency of the generator.



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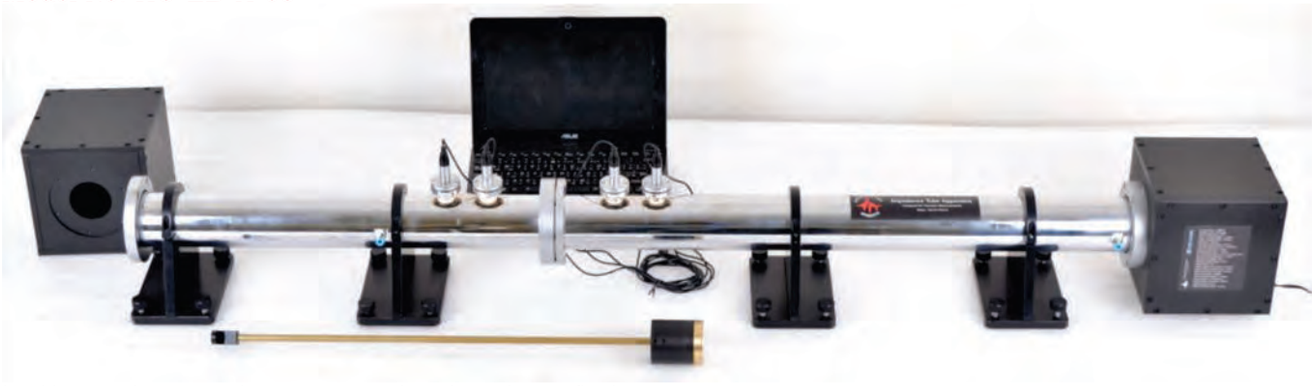
Impedance Tube Apparatus (Absorption Coefficients and Impedance)

Model No: HO-ED-A-03



In this experiment, students measure the absorption, reflection coefficients and acoustic impedance of samples using Impedance tube apparatus. The impedance tube apparatus is commonly used to measure specific impedances, sound absorption coefficients (SACs), sound transmission losses (STLs) and acoustic properties (characteristic impedances, propagation wave numbers, effective densities, bulk moduli) of acoustic materials in normal incidence conditions.

Experiment Examples:

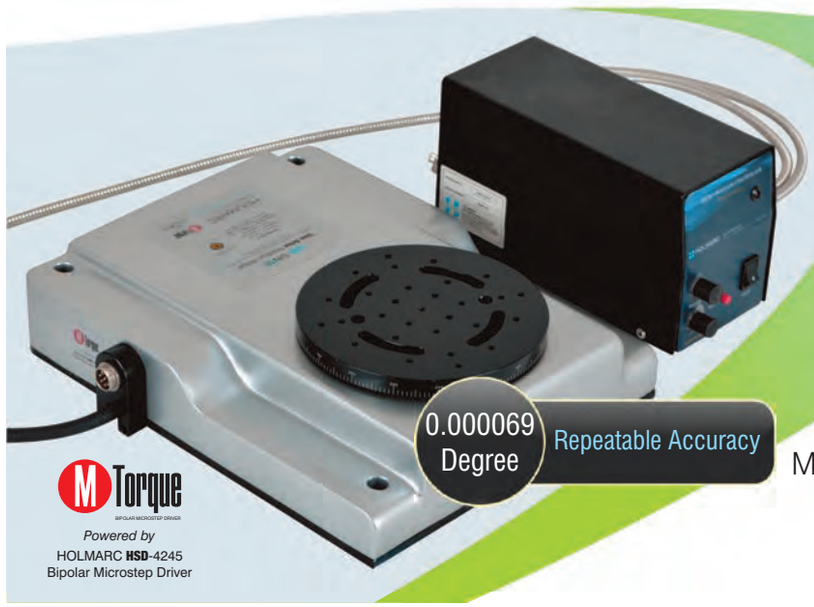
- **Measurement of acoustical properties of materials**
- **Measurement of absorption and reflection coefficient of materials**
- **Measurement of transmission loss**

Measurement techniques are based on ASTME standards. The experiment can be conducted by two microphones and four microphones. System consists of a solid brass tube containing a speaker at one end and the other end with the capability to hold a material sample, whose properties are to be measured. Pair of microphones, separated by finite distance is connected to this tube with the help of microphone holders. These microphones are connected to a digital signal analyzer via signal conditioners (pre-amplifiers) and a data acquisition system. A function generator is used to power the speaker in the impedance tube. Termination conditions differ based on whether to measure absorption or transmission loss. For absorption coefficient measurements, a rigid backing is used. For transmission loss measurement, a hollow tube of the same diameter as the upstream tube with a pair of microphone holders is used on the downstream of the test sample. Two different termination conditions (anechoic and rigid backing) are used during transmission loss measurements.

SPECIFICATION

Impedance tube length	700mm +300mm attachment
Inside diameter	50mm
Speaker frequency range	y Range : 80Hz to 18kHz
Signal generator	20Hz – 20kHz
Sweep in	Automated
Number of microphones	4
Sample holding unit	50mm standard, variable design
Sound wave analyzer	4 Channel integrated wave analyzer
Controls	PC automated measurements
Software	HOLMARC wave analyzer 4C

Sound-absorption ability of the sample is measured in the plane-wave impedance tube. The sound is generated by a loud speaker at one end of the tube and the sample is placed and sealed at the other end of the tube. The sound abortion co-efficent is the absorbed fraction of the energy of a plane sound-wave when incident on the sample material. The co-effient describes the ability of the material to absorb sound in a given frequency band.



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Ultra Precision High-Performance
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The Sin216R series stages are perfect for rotary positioner testing, laser pointing, optical calibration systems and metrology systems. Other specific applications include optical encoder accuracy testing, missile seeker testing, photonic component alignment and precision wafer inspection.

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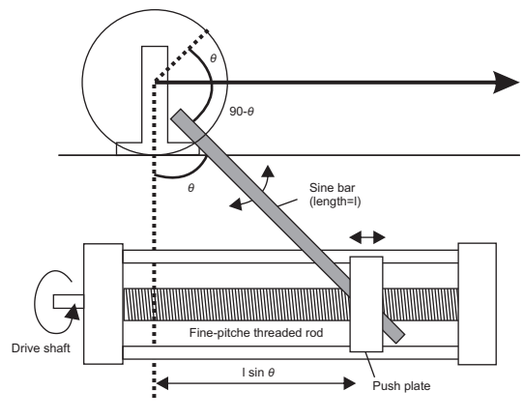
The Sin216R series are ultra-precision computer-controlled rotation stages, developed for fast and accurate positioning applications. Sine-bar mechanism is employed in this device for higher resolution angular positioning. A precision linear translation stage with a high resolution optical encoder is used in the mechanism for achieving angular tilt of the sine bar. The absolute encoder allows instant initialization at the time of power up and eliminates the need for a home cycle. The stepper motor turns the drive lead screw which moves the drive block. The drive block in turn pushes the sine bar to rotate the platform, providing stable and excellent performance in angular positioning.

The principle of sine drive mechanism is shown schematically in Fig. When a lever of length L is rotated through an angle θ about one end, the other end moves through a distance X = L Sin θ perpendicular to the initial position of the lever.

Standard metric M4 mounting holes patterns are provided on the top plate of these stages. Top plate can be used to rotate manually large optical and other components through continuous 360° with accuracy of 1°. Custom mounting patterns can be provided for easy integration with other systems/components.



Our engineers will help you to select appropriate technology, for your application or precision rotary motion, from the drive and bearing system to the encoder and motion controller.

Sine drive rotation stages are also offered in high-vacuum and ultra-high-vacuum configurations.

Holmarc manufactures holographic experiment setup for education as well as research application. The system includes optical tabletop, pneumatic supports, opto - mechanical components, optics, He-Ne laser, holographic plates, processing chemicals, etc. Holography represents one of the most fascinating examples of recombination of scattered radiation to produce pictures. It is a widely used method to produce images and an important tool in science and technology.

Holographic Lab 71
Model No: HO-ED-H-02

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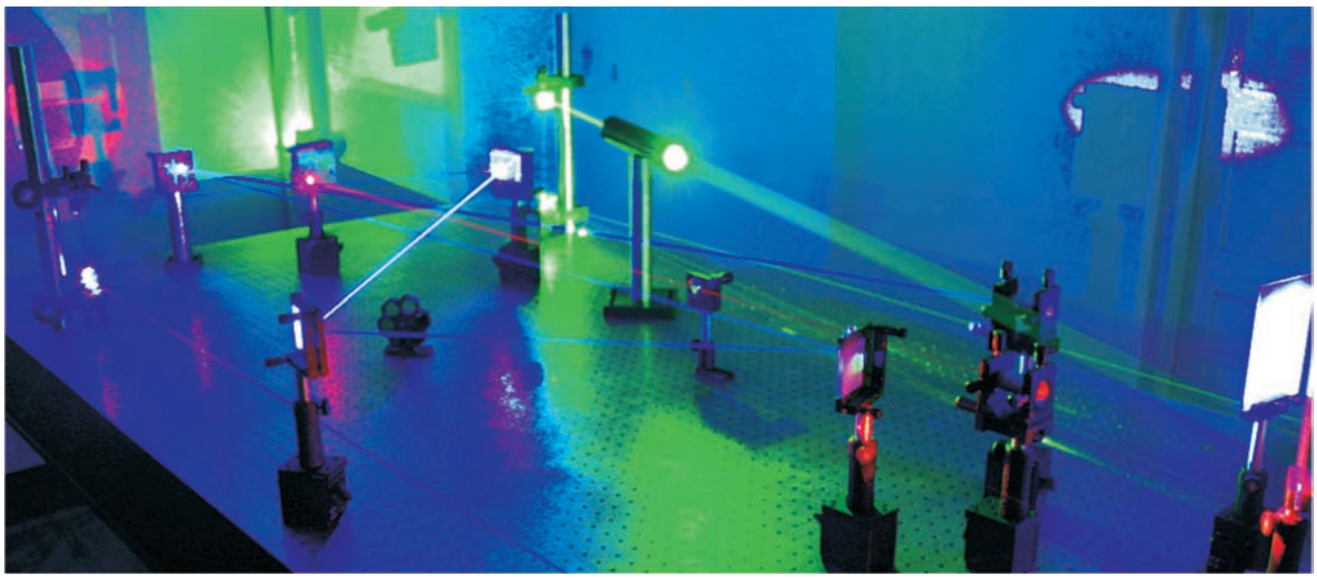
Holographic Lab

Model No: HO-ED-H-02



Holmarc's Holography Lab (Model: HO-ED-H-02) is developed for recording holograms in academic and research institutions. The equipment includes, vibration isolated table, opto-mechanical modules, optical components, sample silver halide plates, processing chemicals etc. All components and modules used in this kit are of industrial quality and reliability. By changing the laser source and recording plates, the equipment can be used for commercial hologram recording as well. In depth training in hologram making is given for all our customers free of cost at our holographic laboratory with either He- Cd or He-Ne lasers

HOLOGRAPHIC LAB - Related Topics

- Holography
- Transmission Holograms
- Reflection Holograms
- Holographic Transmission Gratings

Experiment Examples:

- **Recording of Diffraction Gratings.**
- **Recording and reconstruction of Transmission Holograms.**
- **Recording and reconstruction of Reflection Holograms.**

Holography is known as “lens less photography” in which an image is captured not as an image focused on a film, but as an interference pattern at the film. The recorded holographic image has both phases and amplitude information where as a photographic image has only amplitude information.

A coherent He-Ne laser (632.8nm) is used as the light source. A variable beam splitter splits the laser beam into two. One of the beams illuminates the object and the scattered light from the object illuminate the holographic plate while the second beam directly illuminates the holographic plate. As the path length of both beams are equal, interference fringes will form at the holographic plate and will get recorded. The recorded plate is then chemically developed by washing in developing solution. The developed plate, under proper illumination, produce a three dimensional image of the object.

Scope of supply	Quantity
Optical honeycomb tabletop with pneumatic Isolated support (1800x 1200 x 200mm)	1 no.
Beam steering device with magnetic base	1 no.
Mirror mount with magnetic base (25mm Dia)	3 no.
Mirror mount with magnetic base (50mm Dia)	3 no.
Plate holder with magnetic base	1 no.
Spatial filter assembly with magnetic base (Microscopic objective 20X)	3 no.
Variable beam splitter mount with magnetic base	1 no.
Object holder with magnetic base	1 no.
Laser Clamp	1 no.
Mirror (25mm Dia)	5 no.
Mirror (50mm Dia)	2 no.
Variable beam splitter	1 no.
Helium -Neon Laser (632.8nm, 5mW)	1 no.

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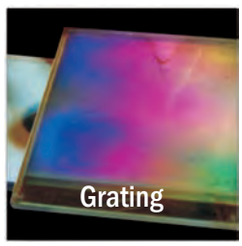
There are many types of holograms, and there are varying ways of classifying them.For our pupose , we can divide them into three types;

Transmission Holograms

A transmission hologram is one where the object and reference beams are incident on the photosensitive plates/films from the same side. A recorded transmission hologram can only be reconstructed using the same light source which is used for recording.

Reflection Holograms

A reflection hologram is one where the object and reference beams are incident on the plates from opposite sides of the plate. The reconstructed object is then viewed by white light from the same side of the plate where the white light is incident.



Holographic Transmission Gratings

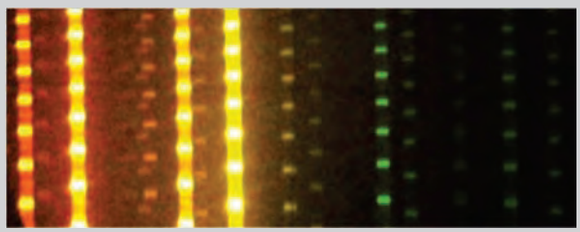
A holographic transmission grating is one where two reference beams are incident on the plates from the same side. The resulting straight line interference fringes will get recorded by the plate. When a white light passes through the transmission grating, it will split the white light into its component spectrum.

INTERFERENCE Spectrometer

Multiple Beam Interference Spectroscopy

Model : HO-S-MBIS-IF215HR

In multiple beam interference spectroscopy (MBIS) a high resolution Fabry-Perot Etalon is used to generate interference fringes over the light spectrum. These fringes are very sensitive to detect wavelength in the range of 0.001nm. HOLMARC's USB 2.0 Spectra IF215HR spectrometer is used to image and record the interference spectrum in the wavelength range of 350nm to 1000nm. It can be directly connected to the PC to monitor the fringe pattern and can save desired spectrum. Below image shows actual interference fringes of spectrum obtained using a IF spectrometer.



Variable Angle **Spectroscopy**

Measurements of Dielectric Materials

Model : HO-S-VAS-300R

Holmarc introduces a new platform for variable angle spectroscopic measurements of optical samples. The main part of this instrument is a precision theta two theta rotation unit powered by Holmarc's popular MRS series rotation stage. 0.0001 resolution can be achieved with this precision stage. With the integration of Spectra UV-VIS-NIR Scanning Spectrometer this instrument becomes an ideal research tool for various measurements. This instrument can be used for Brewster spectroscopy, Spectroscopic refractive index plot, Thin film characterization, Reflection and absorption measurements of various optical samples, Scattering measurements etc.

Mach-Zhender Interferometer

RESEARCH VERSION

Model : HO-ED-INT-12A

Mac Zehnder Interferometer Model No: HO-ED-INT-12A from Holmarc is specifically meant for refractive index measurement of gases in research laboratories. It can as well be used for the study of other parameters like temperature, density and pressure which cause change in refractive index of the media.

The interferometer measures the relative phase shift between two collimated beams from a coherent light source. The versatility of the Mach–Zehnder configuration has led to its use in a wide range of fundamental researches. The light source for our instrument is a DPSS laser having 532nm output wavelength. The phase shift can happen due to a change in optical path length. Variation in the refractive index of the medium for one beam causes change in optical path length and appears as a phase shift. The phase shift is measured as the number of interference fringe movements observed on a screen. As a diagnostic tool, Mac Zehnder inteferometer, by virtue of its working principle, is highly sensitive and precise.

The interferometer is constructed by assembling various modules on an optical breadboard. The mirrors and beam splitters are mounted on precision and stable kinematic holders for fine adjustments. In addition to the kinematic tilt, each one of the mirrors and beam splitters are provided with precision translation for fine adjustment of distances. The laser beam is expanded and collimated for 40 mm diameter parallel beam using beam expander. Vibration isolated supports for optical table is optional. The set up is flexible so that the user can re-align and re-position the modules to suit applications.

The gas cell is placed in one of the interferometer arm. Before introducing the gas under test, the cell is emptied of the atmospheric air by a vacuum pump provided with the system. The required valves, tubes and gauges are included in the instrument. To perform the experiment, the gas cell is filled with the gas from a container to a predetermined pressure. After allowing the entire system to stabilize, the mirror mounts are fine tuned to obtain bright clear circular fringes on the screen. Once the system is ready, pressure in the cell is released slowly with the help of a valve provided noting down the fringe count and pressure drop in the gauge.

Model : HO-ED-INT-12A include optical breadboard, DPSS laser with power supply, beam expander, kinematic beam splitters , kinematic front coated mirrors , gas cell with optical windows, vacuum pump etc.

For more products and informations, please log on to www.holmarc.com

Thin film plays an important role in the development and study of material with new and unique properties. Holmarc provides equipments for characterization and study of thin films using various methods. The equipments listed in this section are useful for research as well as for post graduate education.

Spectrophotometer 74
Model No: HO-ED-TH-01

Variable Angle Laser Ellipsometer. 75
Model No: HO- ED-TH-02

Spectroscopic Ellipsometer 76
Model No: HO-ED-TH-06

Thin film Spectroscopic Reflectometer 77
Model No: HO-ED-TH-04

Theta- 2Theta Advanced Spectrophotometer 78
Model No: HO-ED-TH-05

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Spectrophotometer

Model No: HO-ED-TH-01

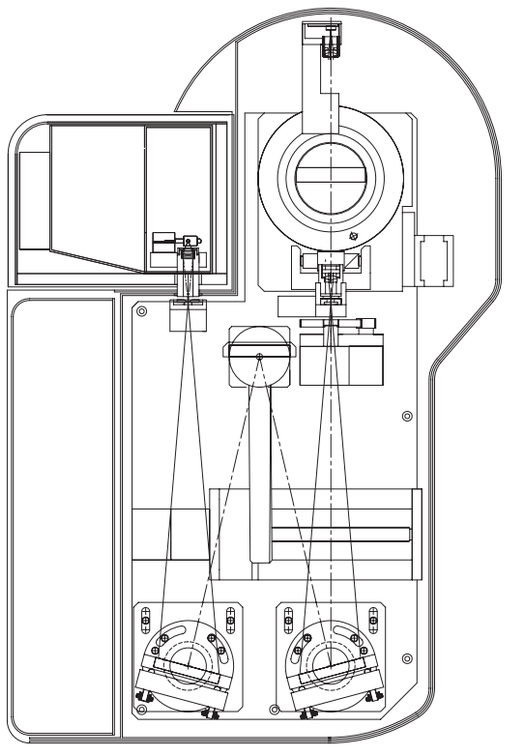
Holmarc's Spectrophotometer (Model No: HO-ED-TH-01) is ideal for education, research and industrial applications. Unlike other entry level spectrophotometers, it employs the classic Czerny - Turner monochromator design, which ensures low stray light. It uses 1200 lines/mm blazed holographic grating as the dispersion element providing high wavelength resolution. It also employs a sigma delta ADC of 16 bit resolution for photometric measurements. A graphic LCD screen is used to plot an absorbance v/s wavelength graph. The data can then be analyzed for peaks and valleys.

In a spectrophotometer, the amount of light passing through the sample cell is measured by a photometer. The photometer delivers a voltage signal to a processing unit. The signal changes as the amount of light absorbed by the liquid changes. According to Beer's law, the amount of light absorbed by a medium is proportional to the concentration of the absorbing material or solute present. Thus the concentration of a colored solute in a solution can be determined in the lab by measuring the absorbance of light at a given wavelength.

The spectrophotometer can measure the amount of absorbance or lack of absorbance of different colored light for a given molecule. The absorbance spectrum is a graph of a sample's absorbance at different wavelengths.

Features:

- Compact and easy to use
- LCD display is large enough to read from any distance
- Selectable resolutions



Experiment Examples:

- To study the absorbance and transmittance of different samples at different wavelengths
- To plot the graph of absorbance Vs. wave length

SPECIFICATION

Wavelength

Range	380 - 1100nm
Resolution	1nm
Accuracy	±1nm
Bandwidth	2nm

Transmittance

Range	0 to 100%
Resolution	0.1%
Accuracy	±1%
Noise levels	<1%
Stability	±1% / Hr after warm-up

Absorbance

Range	0 to 2A
Resolution	0.001A

Concentration:

Range	0 to 999
Selectable resolution	1,0.1,0.01 or 0.001

Readout	320 x 240 Pixels graphics LCD
PC Interface	RS232 (optional)
Light source	Tungsten halogen lamp 20W

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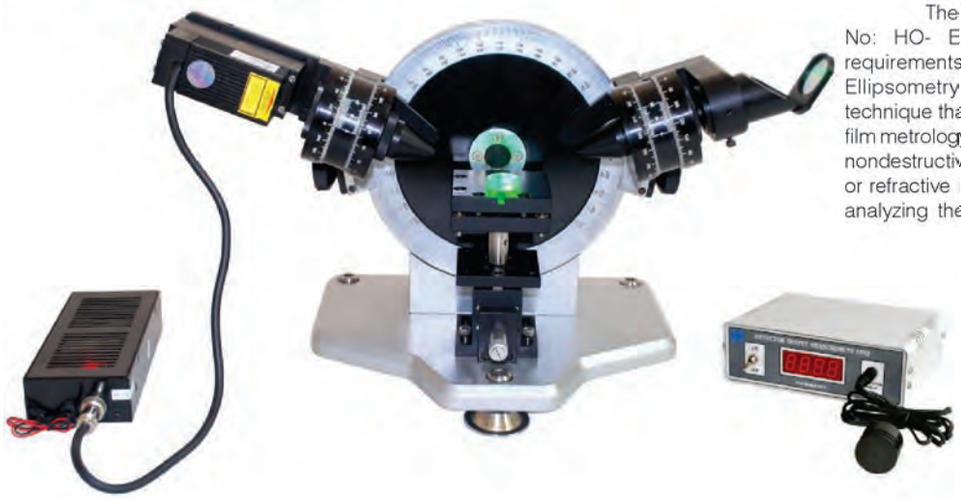
Variable Angle Laser Ellipsometer

Model No: HO- ED-TH-02



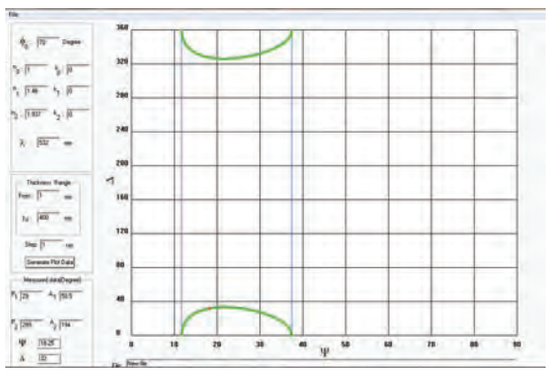
The Variable Angle Laser Ellipsometer (Model No: HO- ED-TH-02) is designed to meet the requirements of modern research and studies. Ellipsometry is a very sensitive measurement technique that provide unequaled capabilities for thin film metrology. As an optical technique, ellipsometry is nondestructive and contact less. The optical thickness or refractive ndex of a thin film can be calculated by analyzing the polarization changes.

Holmarc's Ellipsometer provides easy operation, precise measurement and user friendly software. Students can gain deep knowledge in the working principles of Ellipsometer and its practical use.

VARIABLE ANGLE ELLIPSOMETER - Related Topics

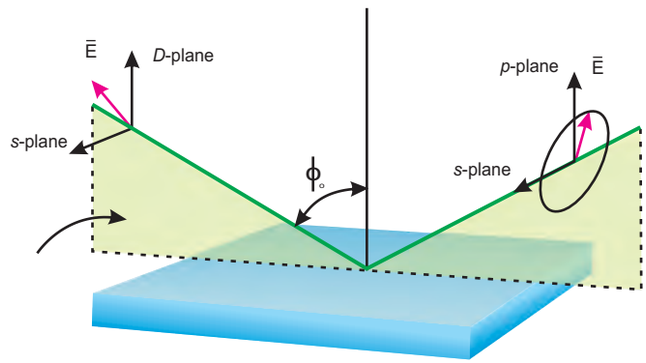
- Polarization of light
- Ellipsometry
- Quarter wave plate

Ellipsometry measures the change of polarization upon reflection or transmission. Typically, ellipsometry is done only in reflection setup. The exact nature of the polarization change is determined by the analysis of the sample's properties like thickness, complex refractive index, etc. Although optical techniques are inherently diffraction limited, ellipsometry exploits phase information and polarization state of light and hence can achieve angstrom level resolution. In its simplest form, the technique is applicable to thin films with thickness less than a micrometer to several nanometers.



Software window

First an input beam of random polarization is converted into a linearly polarized beam by making it pass through a polarizer. It is then converted to an elliptically polarized beam using a quarter wave plate and made incident on the thin film sample to be measured. The polarization status of the reflected beam from the film gets altered.



Experiment Examples:

- Study of refractive index of thin films
- Thickness of thin film samples

SPECIFICATION

Measurement range	1 nm ~ 300 nm
Incident angle	30° ~ 90°, Error ≤ 0.1
DPSS laser	532nm, 5mW
Si Photodiode	5.8 x 5.8mm active area

Rotation range

Polarizer	0° ~ 360°
Quarter-wave	0° ~ 360°
Analyzer	0° ~ 360°
Laser arm	70° (from horizontal plane)
Detector arm	70° (from horizontal plane)
Resolution	0.1 degree

Variable Angle Spectroscopic Ellipsometer

Model No: HO-ED-TH-06

Spectroscopic ellipsometer is widely used for thin film analysis and measurements. Holmarc's spectroscopic ellipsometer incorporates Rotating Analyzer Ellipsometry technology to characterize thin film samples. It uses a high speed CCD array detection to collect the entire spectrum. It measures films from nanometer thickness up to tens of microns and the optical properties from transparent to absorbing materials. It accurately measures optical constants like refractive index, film thickness and extinction coefficient.

Features:

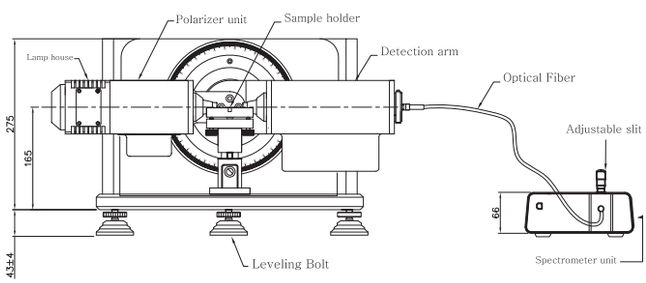
- Non-destructive and non-contact technique
- Analysis of single and multilayer samples
- Accurate measurements of ultra-thin films
- Software for measurement, modeling and automatic operations.
- All range of (Ψ, Δ) can be measured.
- Uniform sensitivity for (Ψ, Δ)

Principle of Ellipsometry

Ellipsometry is a highly sensitive technique for thin film analysis. The principle relies on the changes in the polarization state of light when reflecting from a surface. To characterize the polarization state, corresponding to the direction of the electric filed of the electromagnetic wave; two directions are chosen as reference, p-direction (parallel) and s-direction (perpendicular). The reflected light has phase changes that are different for p-direction and s-direction. Ellipsometry measure this state of polarization;

$$p = r_p / r_s = \tan \Psi e^{i\Delta}$$

Where Ψ and Δ are the amplitude ratio and phase shift of the 'p' and 's' components respectively. Since ellipsometry measures ratio of two values, it is very accurate and repeatable.



Our standard system comes with Quartz-Halogen lamp from visible to IR range. Our spectroscopic ellipsometer software allows the user to measure and analyze multilayer thin films and complex thin film structures. An autocollimator, Z stage and tilt platforms are provided for sample alignment. XY motorized stage and motorized rotation stages are provided as an optional feature for mapping thin film uniformity.

SPECIFICATION

Spectral range	450 - 800nm
Detector	CCD
Resolution	2nm
Light source	Halogen lamp
Goniometer	40 - 90 degree (Resolution: 0.1 degree, Automated operation)
Thickness measurement range	0.1nm - 10micron
Resolution of film thickness	0.01nm
Resolution of measured R.I.	0.001
Sample alignment	Semi-automated (optical detection) with manual 10mm height adjustment and tilt
Sample stage features	X - Y translation over 10 x 10mm (optional)
Measurable film parameters	Refractive index, extinction coefficient, absorption coefficient and film thickness

Software Features:

- Acquisition and analysis of psi, delta and reflectance at different wavelengths and angles
- User extendable materials library
- Data can be saved as an Excel or text file
- Advanced mathematical fitting algorithm
- Extraction of thickness and optical constants
- Parameterized models
- Multi layer thickness measurements

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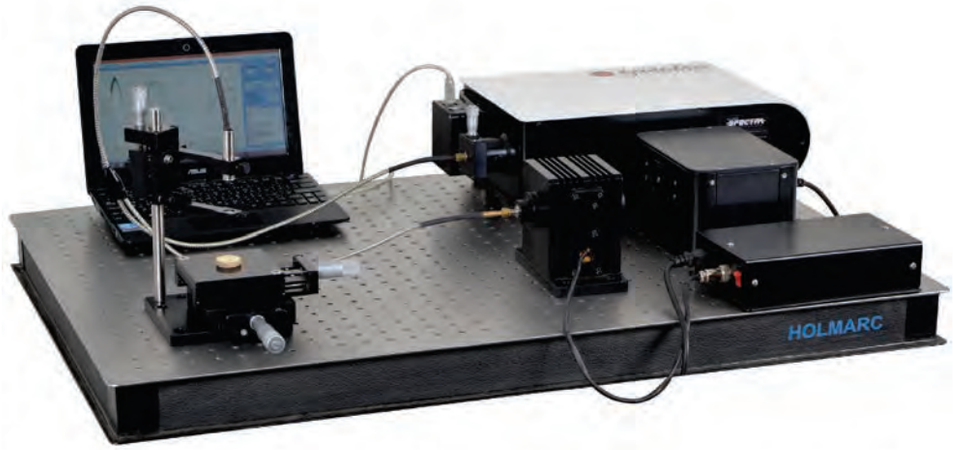
Thin film Spectroscopic Reflectometer

Model No:HO-ED-TH-04

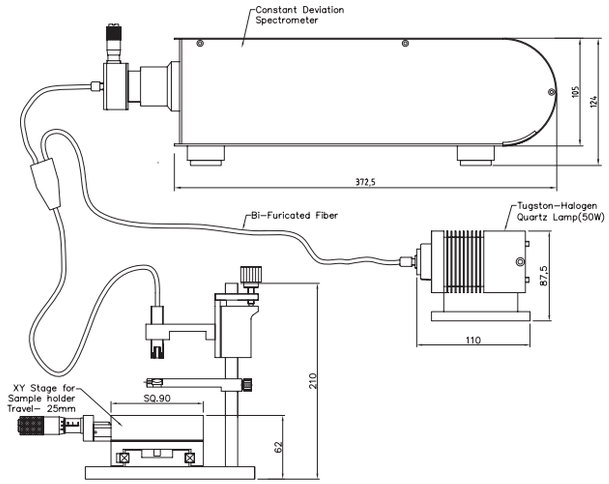
Thin Film Spectroscopic Reflectometer is a fundamental instrument used for the analysis of thin film thickness in industry and research. Holmarc's TFSR Model No: HO-ED-TH-04 is able to analyze thin film's thickness, complex refractive index and surface roughness with high speed and repeatability. TFSR theory works with complex matrix form of Fresnel equations for reflectance and transmittance. Absolute reflectance spectroscopy is the principle behind Reflectometer; which is the ratio of the intensity of the reflected light beam (usually monochromatic) to the intensity of the incident beam.



Light beam normally incident on the sample surface in turn reflect from top and bottom of the thin film surfaces which get interfered and is directed through optical fiber to CCD attached spectrometer via computer. On the monitor we get spectrogram with interference oscillations directly proportional to the thin film thickness.

Features:

- Analyze single or multi-layer films
- Fiber optic probe for reflectance measurements at normal incident angle
- CCD linear array image sensor for simultaneous measurement of reflectance at each wavelength
- User extendable materials library
- Data can be saved as an Excel or text file
- Advanced mathematical fitting algorithm
- FFT based thickness measurement
- Extraction of thickness and optical constants
- Parameterized models



Holmarc's Reflectometer can be used to analyze single, multi-layer, free standing and rough layer thickness of various stacks such as di-electric, crystalline, amorphous, metallic and absorbing samples. It also finds absolute transmittance and absorption directly. Roughness treatment is done with EMA modeling. The instrument can also be used to find optical conductivity, molar refractivity and Brewster's angle of sample under study.

SPECIFICATION

Film thickness range	25 nm - 1 μm
Reflectance wavelength range	400 nm - 900 nm
Transmittance / absorbance range	0 - 100%
Light source	Tungsten Halogen Quartz Lamp, 50W
Detector	CCD linear array, 3648 pixels
Spectrometer	Spectra CDS 215
Spectrometer wavelength range	VIS - NIR
Precision typically for SiO2 on NSF - 66	± 5 nm
Accuracy for same sample	± 10 nm
Optical power	20 W
Light spot size	1 mm
Spot size on sample	5 mm
Optical fiber	Multimode Bi-furcated fiber with SMA fiber coupler
Reference sample	Enhanced silver with Yttrium & Bare Aluminum
Standard sample	SiO2 thin film on NSF - 66 Substrate
Measuring modes	Curve fitting / Regression Algorithms, FFT, FFT + Curve Fit
Dispersion formulas	Cauchy's, Sellmeiers, FFT & Empirical models
EMA models	Linear EMA, Bruggemann, Maxwell Garnett, Lorentz - Lorenz models
Material library	Extendable material user library
PC interface	RS232 / USB

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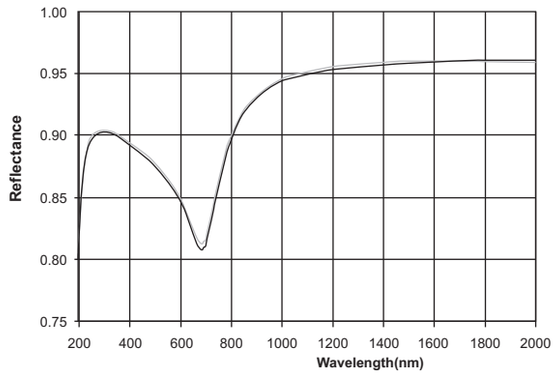
Theta 2 Theta Advanced Spectrophotometer

Model No:HO-ED-TH-05

The need for reliable measurement techniques for optical characterisation of thin films is growing. HOLMARC's Theta 2 Theta Spectrophotometer is a useful tool for characterizing the absorption, transmission and reflectivity of a variety of scientifically important materials, such as pigments, coatings, windows, and filters. Automated theta 2 theta goniometer tool is used for variable angle spectroscopy, measuring absolute reflectance and transmittance of samples at different angles for characterization of the optical or electronic properties of materials. Reflectance measurements can measure color of a sample or examine differences between objects for sorting and quality control.

Features:

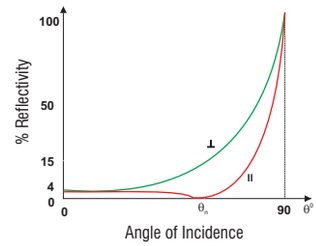
- Specially designed for optical characterization
- Ideal for reflectance, transmission, absorption and optical density measurements.
- Design optimized for low stray light.
- Interchangeable holders for solid, liquid and thin film samples.
- Wide range of accessories such as polarizers, filters etc



This advanced spectrophotometer gives precise measurements of spectral parameters such as reflection, transmission, and optical density in all spectral range of UV, VIS and NIR. Spectral transmission and reflection measurements at any desired angle with a resolution of 0.5^0 can be carried out with this spectrophotometer. Two reserch models are available for angular photometric measurements HO-SPA-1990P and HO-SPA-3411D. The model:HO-SPA-1990P is a scientific grade photometer equipped with high sensitive photo multiplier tube, while Model : HO-SPA-3411D uses Si Photo diode as detector. Angles for illumination and measurement can be set independently. The system has provision to add motorized polarizer and analyzer to get the polarization curve of the sample at various angles.

The device employs classic Czerny - Turner monochromator design, which ensures low stray light. It uses 1200 lines/mm blazed holographic grating as the dispersion element, providing high wavelength resolution. It also employs a sigma delta ADC of 16 bit resolution, for photometric measurements. Customized accessories are available to address individual application requirements.

Model	HO-SPA-3411D	HO-SPA-1990P
Bandwidth	1nm	0.5nm
Optical System	C-T monochromator, 1200 l/mm holographic grating	
Wavelength Range	340 ~1100nm	190 ~ 900nm
Photometric Method	Transmittance, Absorbance, Concentration	
Wavelength Accuracy	±0.5nm	
Wavelength Repeatability	±0.1nm	
Absorbance Range	-3 ~ 3Abs	
Photometric Accuracy	±0.002A (0 ~ 0.5A), ±0.004A (0.5 ~ 1A), ±0.3% T	
Photometric Repeatability	≤0.001A (0 ~ 0.5A), ≤0.002A (0.5 ~ 1A), ±0.1% T	
Stray Light	≤0.05% T	
Baseline Straightness	±0.002A	
Detector	Si-Photodiode	PMT
Light Source	Quartz Halogen Lamp	Xenon Arc Lamp
Cell Holder	Two-position 10mm standard cuvette holder	
Theta 2 Theta Measurements	Goniometer for Angular Measurements Type : Theta 2 Theta Measuring Stage Sample Holder : Up to 50x50mm size, Custom Size Available Angular Measurement Range : 30^0 - 180^0 Positioning Resolution : 0.5^0	
Control Mode	PC control (Software : PhotoANALYTE-G)	
Dimensions (LxWxH) mm	606x352x135	606x352x230



The software developed for this instrument has facilities for setting up and calibration in addition to scanning and manual readout. Scanning is possible for a desired wavelength range as well. This feature can save time whenever full wavelength range scan is not necessary. The software saves and displays the data acquired on MS Excel sheet. This helps to plot graph with ease whenever required.

A variety of accessories are included, such as test tube holder, temperature control holder, long path length cuvette holder and multiple cell holder. These accessories can be used to enhance various application needs.

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Solar cells are described as being photo-voltaic irrespective of whether the source is sunlight or an artificial light. They are used as a photo detector, detecting light or other electromagnetic radiation near the visible range or measuring light intensity.

In this section, Holmarc introduces some apparatus that are helpful for the study of solar cells with a modified approach.

Solar Cell Characterization Apparatus (I-V Characteristics) 79
Model No: HO-ED-SC-01

Spectral Response Measurement Apparatus 80
Model No: HO-ED-SC-02

Quantum Efficiency Measurement Apparatus 81
Model No: HO-ED-SC-03

Thermally Stimulated Current (TSC) Spectrometer 82
Model No: HO-ED-SC-04

Conductivity Cell Measurement Apparatus 83
Model No: HO-ED-SC-05

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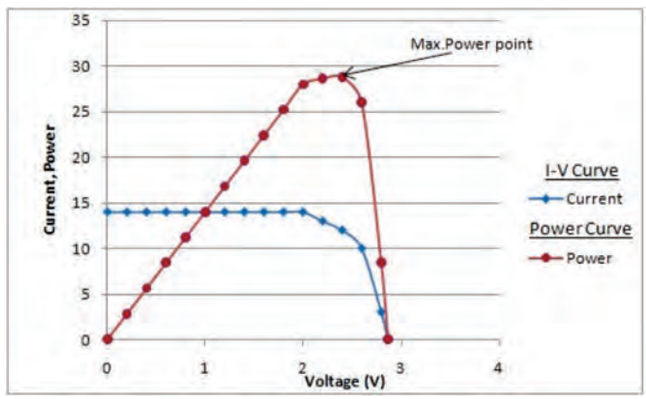
Solar Cell Characterization Apparatus (I-V Characteristics)

Model No: HO-ED-SC-01

Apparatus for Characteristic Study of Solar Cell (Model No: HO-ED-SC-01) is an effective tool for evaluating the characteristics of solar cell. This apparatus allows students in introductory physics course to plot I-V characteristics of a solar cell by a simple experiment. Important parameters such as fill factor, short circuit current, and open circuit voltage can be measured.

SOLAR CELL CHARACTERIZATION APPARATUS - Related Topics

- Diode
- Energy-band
- Conduction band
- Photocurrent
- Valence band

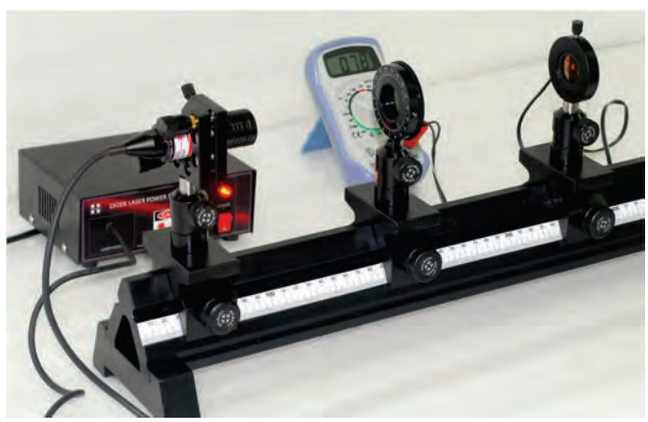


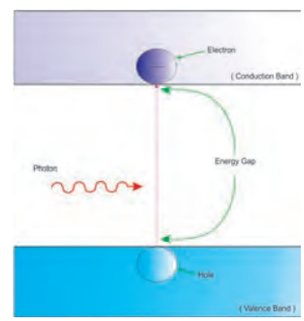
The apparatus consist of variable DC power supply, LED, solar cell and two multimeters (or an ammeter and a voltmeter). A variable DC power supply of 0-5V is used for conducting the experiment. Light source is provided by LED. The illumination intensity of the LED can be controlled. LED and solar cell is fixed to metallic casings for ease of placing in the experimental set up. The terminals of LED and solar cell are taken out through an insulated wire, which has a pair of alligator clips or a stereo connector.

Solar cells can absorb electromagnetic waves and convert the absorbed photon energy into electrical energy. It is a semiconductor device, which generates an emf when illuminated by light. When the energy of the incident photon is larger than the band gap, the photon can be absorbed by the semiconductor to create an electron-hole pair. The electrons and holes are then driven by the internal electric field in the diode to produce a photocurrent (light-generated current).

Experiment Examples:

- To plot the I-V characteristic curve of a solar cell
- To observe the relationship of current, voltage and power in a solar cell , and to identify the maximum power point, the short circuit current, and the open circuit voltage
- To evaluate fill factor of the solar cell





Scope of supply	Quantity
DC power supply (0 - 5V DC Variable)	1 no.
Cell mount	1 no.
Solar cell	1 no.
LED with mount	1 no.
Multimeter	2 nos.
Connecting cords with alligator clips	2 nos.

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Spectral Response Measurement Apparatus

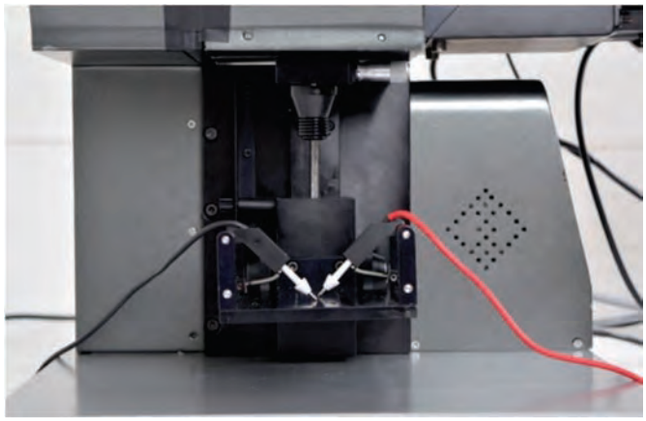
Model No: HO-ED-SC-02

Spectral response is the ratio of the current generated by the solar cell to the power incident on the solar cell or a detector. Spectral response measurement apparatus measures short circuit current of solar cell at selected wavelengths over a broad range of wavelengths.

HOLMARC's Spectral response measurement system (Model NO: HO-ED-SC-02) is capable of measuring the spectral response of any kind of photovoltaic devices, such as single or multi junction solar cells or sensors in an area up to 30mm^2 .Measurements can be taken in the wavelength range from 300 to 1600nm at a resolution of 1nm. It is also possible to apply light or voltage bias up to 10V during the measurements. Current, normalized with respect to light power versus wavelength gives spectral response of the cell. Spectral response is directly related to external quantum efficiency. The measurements can be performed manually using onboard controls or automatically by interfacing to a computer.

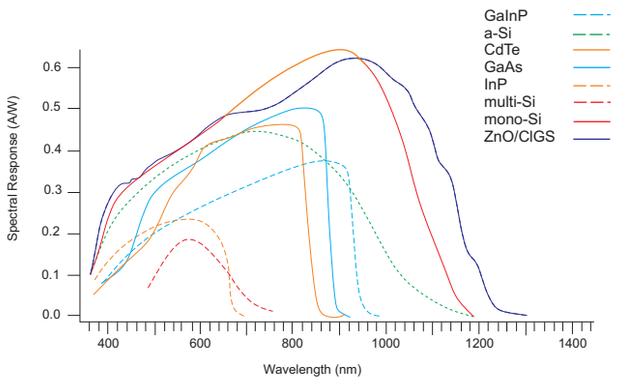
Experiment Example:

- To measure spectral response of a solar cell



Features:

- The system can be used in standalone mode.
- 20 x 4 line LCD, keyboard and PC software for user interface
- Plot browser to read spectral response at each wavelength
- Wavelength range between 200 and 1400nm
- Stepping motor scanning for precision wavelength positioning.



SPECIFICATION

Optical path	Czerny-Turner configuration
Scanning range	200-1100nm (Default)
Absolute diffraction efficiency	45-65%
Resolution	0.1nm (@546nm, 10μm slit width)
Wavelength accuracy	⩽0.2nm
Wavelength repeatability	⩽0.1nm
Stray light	⩽10-3
Reciprocal of linear dispersion	2.7mm
Half-width of spectral line	⩽0.2nm @586nm

SPECTRAL RESPONSE APPARATUS - Related Topics

- Spectral response of solar cell
- External quantum efficiency
- Fermi energy level
- Photovoltaic device

Quantum Efficiency Measurement Apparatus

Model No: HO-ED-SC-03

The spectral responsivity or quantum efficiency (QE) is essential for understanding current generation, recombination, and diffusion mechanisms in photovoltaic devices. PV cell and module calibrations often require a spectral correction factor that uses the QE. The quantum efficiency in units of electron - hole pairs collected per incident photon is computed from the measured spectral response in units of amperes per watt as a function of wavelength.

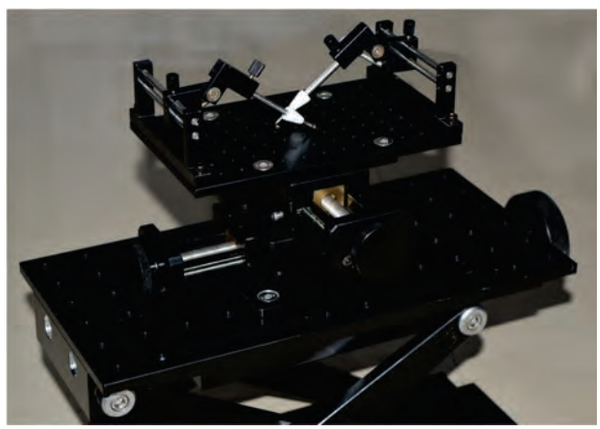
MODEL: HO-ED-SC-03 is integrated with 150W Xenon lamp with housing, optics and power supply with capability to measure dark lighted IV characteristics of solar cell and quantum efficiency measurement (300nm-1600nm). Computer enabled for recording data is a standard feature.

Experiment Examples:

- **Efficiency measurement of Standalone Solar PV System**
- **Measurement of current – voltage characteristics of crystalline silicon solar cell**
  - **a) Measurement by using 4 quadrant power supply and solar cell as load**
    - **i) in dark and ii) under illumination.**
  - **b) Measurement by using solar cell as power source under illumination**
- **Measurement of current-voltage characteristics of two solar cells connected**
  - **i) in series and ii) in parallel.**
- **Dependence of current- voltage characteristics of crystalline silicon solar cell on**
  - **a) light intensity and b) temperature of solar cell**

System consists of:

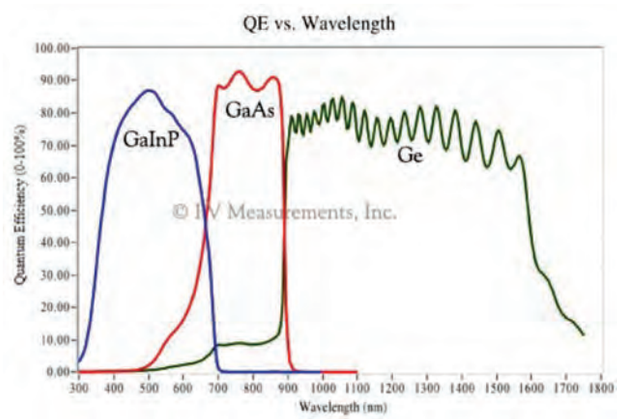
1. 150 W Xenon Lamp with integrated power supply
2. 300F Quasar Monochromator (300-1600 nm) with order sorting filters.
3. Selectable flip mirror assembly for quantum efficiency measurement / lighted I-V measurement. For lighted IV a collimated beam of 50 mm diameter is used.
4. Sample holding and x-y manual positioning unit arrangement helps to keep the sample horizontally. Sample is placed on a chuck held by vacuum.



5. Electronics to measure dark and lighted I-V Characteristics: Current range - 0.1 μA to 0.75 A. Voltage range -5V to +5 V
6. Sample stage with vacuum chuck
7. Chopper and lock in amplifier.

System includes a sample stage, capable of accommodating samples up to 50 mm diameter and probes to contact the sample. Sample is held by vacuum. Light is normally incident on the sample. Fixed frequency chopper and lock in amplifier are used for modulating the light at a frequency of 400Hz for measuring spectral response. This allows current measurement capability from minimum of 0.1 μA to 1 mA. Wavelength resolution of monochromator is 0.1nm. Illumination area can be adjusted using lens assembly system.

It can also be used for characterization / measurement of the imaging systems (cameras) and other detectors in terms of linearity range, spatial non-uniformity of response (the variation of responsivity across the active area of a detector), temperature coefficient of response etc.



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Thermally Stimulated Current (TSC)Spectrometer

Model No: HO-ED-SC-04

Holmarc's Thermally stimulated current (TSC) spectrometer is used to study energy levels in semiconductors or insulators, especially solar cells. The sample energy levels are first filled by exposing it to a halogen lamp light source for a user specified time. The temperature of the sample at this time can be set as low as 70 ^{0}C. The sample can then be heated gradually up to 150^{0}C at a specified ramping rate which causes emission of electrons and holes in the sample.

This emission is measured at different points of temperatures, by applying a voltage and measuring the resulting current. A curve of emitted current is recorded and plotted against temperature, by the software, resulting in a TSC spectrum. By analyzing TSC spectra, information can be obtained regarding energy levels in the sample.

SPECIFICATION

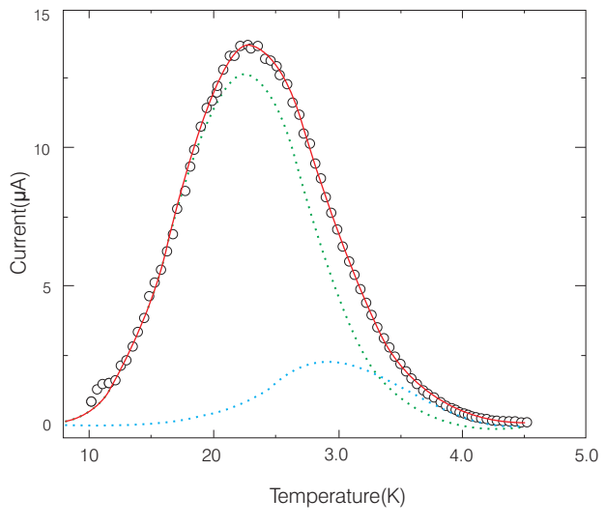
Temperature range	-70^{0}C to 150^{0}C
Coolant	Liquid nitrogen
Sample holder diameter (Suitable for standard laboratory glass slide)	5cm (Suitable for standard laboratory glass slide)
Light source	Tungsten halogen lamp
Drive voltage	0.2V to 2V
Measurement resolution	0.1nA
Measurement accuracy	1nA
PC interface	RS232

THERMALLY STIMULATED CURRENT (TSC)SPECTROMETER - Related Topics

- Semiconductors
- Insulators
- Solar cell
- TSC Spectrum

Experiment Example:

- To study energy levels in semiconductors or insulators, especially solar cells



A driving force is required for emitted carriers to flow when the sample temperature is being increased. This driving force can be an electric field or a temperature gradient. In Holmarc's TSC Spectrometer, this driving force is a voltage in the range of 0.2 to 2V. The sample heating is accomplished using a sample holder with embedded resistive heating element. The sample holder also has piping to carry liquid nitrogen to facilitate cooling up to -70 Degree Celsius. The Nitrogen cylinder can be purchased along with the spectrometer, which should be filled with liquid Nitrogen before operation.

The sample chamber can accommodate substrates of diameters up to 5 cm. The high resolution current measurement circuit has a resolution of 0.1 nA and accuracy of 1 nA. The T-Spectro software which comes with the system enables automatic scanning and data acquisition from the system. The scan parameters and results can be saved for later use. The software works with any PC with minimal specifications and which runs Windows XP, 7, 8.1 or 10.

Application

- Study of dielectric materials and polymers
- Traps in semi-insulating Gallium Arsenide (GaAs) substrates
- High resistivity Silicon, Cadmium Telluride and other materials used in particle and semiconductor detectors
- Organic insulators

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Conductivity Cell Measurement Setup

Model No: HO-ED-SC-05

HOLMARC'S Model: HO-ED-SC-05 is a computerized conductivity setup to measure the conductivity of the semiconducting thin film samples by varying temperature in vacuum.

Temperature of the sample at the time of measurement can be set at a range of ambient to 150^{0}C. The conductivity is measured at different points of temperatures, by applying a voltage range from 0 -300V and measuring the resulting current. A curve of current is recorded and plotted against temperature by the software. The process is carried out inside a vacuum chamber of up to 10^{-2} mbar vacuum pressure. Rotary vacuum pump is supplied along with the instrument.

SPECIFICATION

Temperature range	Ambient to 150^{0}C
Sample holder diameter	5cm (Suitable for standard laboratory glass slide)
Drive voltage	0 to 300V
Measurement resolution	0.1nA
Measurement accuracy	1nA
PC interface	RS232

Experiment Example:

- **To measure the conductivity of semiconducting thin film samples.**

CONDUCTIVITY CELL MEASUREMENT SETUP - Related Topics

- Conductivity
- Thin film
- Thermal conductivity

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Astrophysics is a branch of space science that applies laws of physics and chemistry to explain the birth, life and death of stars, planets, galaxies, nebulae and other objects in the Universe.

Equipments described in this section helps students to acquire knowledge about new areas of the Universe.

Solar Characteristics Measurement Set up 84
Model No: HO-ED-AP-01

Astronomy & Astrophysics Experiment Set up 87
Model No: HO-ED-AP-04

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Solar Characteristics measurement set up

Model No: HO-ED-AP-01

Holmarc has introduced new experiments for solar physics. It is a branch of astrophysics that specializes in exploiting and explaining the detailed measurements that are possible only for our closest star.

The base of all experiments in this kit is to study our Sun. Because the Sun is uniquely situated for close-range observation (other stars cannot be resolved with anything like the spatial or temporal resolution that the Sun can) there is a split between the related discipline of observational astrophysics (of distant stars) and observational solar physics.


HOLMARC ASTRO SKY VIEW 900F TELESCOPE IMAGE - Sun Spot 08 Nov 2013

Experiment Example:

- Solar Limb Darkening Effect
- Sun Spot & Flares
- Solar Radiation Spectrum
- Measurement of Sunshine Duration
- Atmospheric Extinction Study
- Perihelion & Aphelion
- Solar Eclipse & Other transits

TELESCOPES

HOLMARC NEWTONIAN REFLECTIVE TELESCOPES FOR SOLAR OBSERVATION

★★★

Model : HO-AAP-SV315SP REFLECTIVE TELESCOPES

300mm Dia 1500mm FL Newtonian Telescope
Optics : High performance diffraction free optics
Coating : Metallic Aluminium Coating with SiO over coat for durability
Movement : Manual Horizontal and vertical scanning
Filter : Equipped with Solar Filter and Large sensor CCD Camera

★★★★

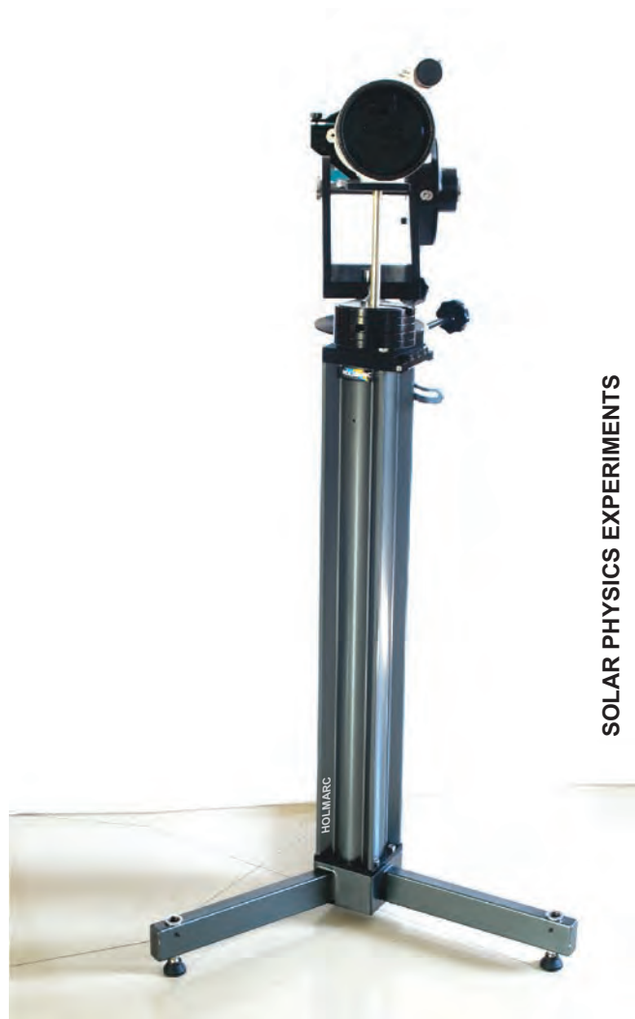
Model : HO-AAP-SV418SP REFLECTIVE TELESCOPES

400mm Dia 1800mm FL Newtonian Telescope
Optics : High performance diffraction free optics
Coating : Metallic Aluminium Coating with SiO over coat for durability
Movement : Manual Horizontal and vertical scanning
Filter : Equipped with Solar Filter and Large sensor CCD Camera

★★★★★

Model : HO-AAP-SV522SP REFLECTIVE TELESCOPES

500mm Dia 2200mm FL Automated Newtonian Telescope
Optics : High performance diffraction free optics
Coating : Metallic Aluminium Coating with SiO over coat for durability
Movement : Manual Horizontal and vertical scanning
Filter : Equipped with Solar Filter and Large sensor CCD Camera



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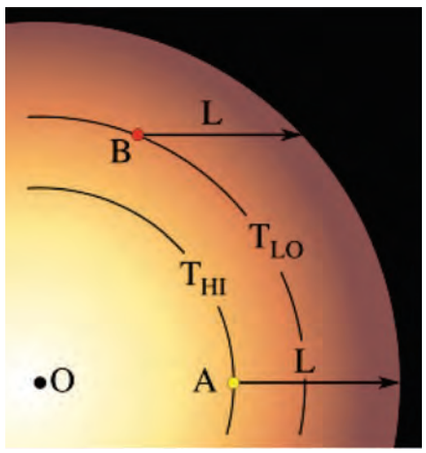
Experiments

1. Solar Limb Darkening Effect

Limb darkening refers to the diminishing of intensity in the image of a star as the star moves from the center of the image to the edge or "limb" of the image. Limb darkening occurs as the result of two effects:

1. The density of the star diminishes as the distance from the center increases

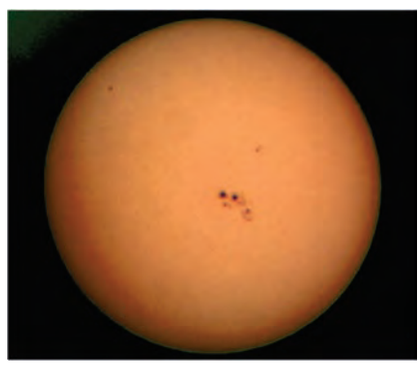
2. The temperature of the star diminishes as the distance from the center increases.



2. Sun spot

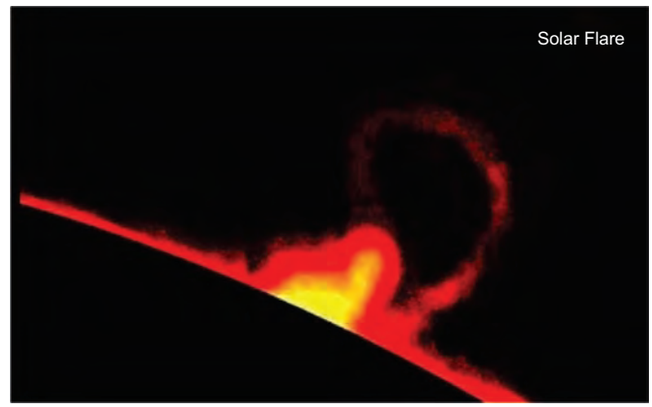
Sunspots are temporary phenomena on the photosphere of the Sun that appear visibly as dark spots compared to surrounding regions. They are caused by intense magnetic activity, which inhibits convection by an effect comparable to the eddy current brake, forming areas of reduced surface temperature. They usually appear as pairs, with each sunspot having the opposite magnetic pole to the other.

Although they are at temperatures of roughly 2700–4200 °C, the contrast with the surrounding material at about 5,500 °C leaves them clearly visible as dark spots, as the luminous intensity of a heated black body (closely approximated by the photosphere) is a function of temperature to the fourth power. If the sunspot is isolated from the surrounding photosphere it would be brighter than the Moon. Sunspots expand and contract as they move across the surface of the Sun and can be as small as 16 kilometers (10 mi) and as large as 160,000 kilometers (100,000 mi) in diameter, making the larger ones visible from Earth without the aid of a telescope.



3. Solar flares

A solar flare is a sudden brightening observed over the Sun's surface or the solar limb, that is interpreted as a large energy release up to 6×10^{25} joules of energy (about a sixth of the total energy output of the Sun in every second). The frequency of occurrence of solar flares varies, from several per day when the Sun is particularly "active" to less than one per week when the Sun is "quiet", following the 11-year cycle (the solar cycle). Large flares are less frequent than smaller ones.



4. Solar Radiation Spectrum

Solar radiation is partly absorbed, scattered and reflected by molecules, aerosols, water vapor and clouds as it passes through the atmosphere. The solar beam arriving directly at the earth's surface is called direct solar radiation. Direct solar radiation is observed from sunrise to sunset.

Using a solar radiation scanning spectrometer solar radiation spectrum is continuously monitored and recorded from a range of 350-1100nm. With the help of motorized solar tracker, solar spectrum in various zenith angles can be recorded (looking vertically, the zenith angle is 0^0, and is 90^0 at the horizon).

Solar Radiation Spectrometer

The software developed for the instrument has facilities for setting up and calibration in addition to scanning and manual readout. Scanning is possible for desired wavelength range as well. This feature can save time whenever full wavelength range scan is not necessary. The software saves and displays the data acquired on MS Excel sheet. This helps to plot graph with ease whenever required.

5. Measurement of Sunshine Duration

Sun photometer unit with tracking mechanism is used for this application. Using photodiode the light intensity of solar radiation is measured continuously. Although the radiation received by the photodetector contains both direct solar radiation and diffuse sky radiation, the latter is removed by differentiating the output signal.

6. Atmospheric Extinction Study

Atmospheric extinction is the reduction in brightness of stellar objects as their photons pass through our atmosphere. Two different mechanisms contribute to extinction: absorption and scattering. Normally, most of the extinction in the Earth's atmosphere is due to scattering; absorption becomes important when the air is full of smoke. Extinction is much stronger in blue light than in red light. This effect is usually called "reddening".

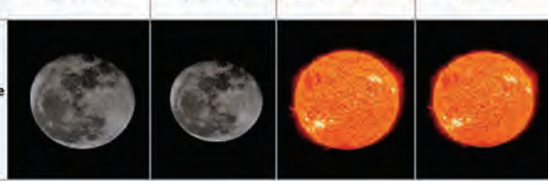
Extinction values for different wavelengths in various angles (looking vertically, the zenith angle is 0^0, and is 90^0 at the horizon) can be measured using Solar scope with tracker and narrow bandpass interference filters. Four interference filters can be accommodated in the Solar scope.

7. Perihelion & Aphelion and Perigee & Apogee Measurements

Aphelion - perihelion and perigee - apogee. Both mean different things. Perihelion and aphelion is about the minimum and maximum distance between Earth and Sun, and the perigee and apogee, refers to the minimum and maximum distance between the Moon and Earth.

Distance between Earth and Sun

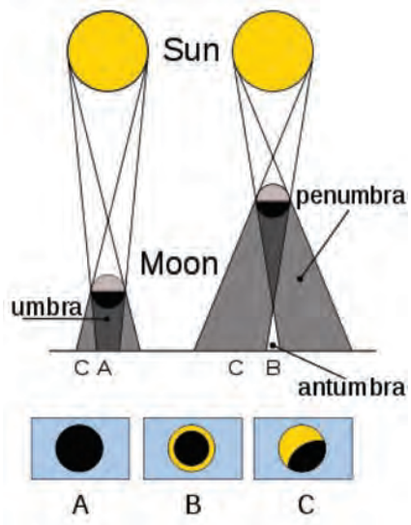
The average distance is about 150 million kilometers (149.6). This distance of 149.6, is defined as an astronomical unit or 1 AU, and is equal to about 8.2 light minutes, because light from the Sun, takes about 8 minutes to reach the Earth. In fact Earth's orbit is not perfectly circular, so the distance between Earth and Sun varies slightly over the year, from a minimum of 147,100,000 km to a maximum of 152,100,000 km. So semi-major axis of Earth's orbit is 149597887.5 km (149.6). When closest to the Sun (or perihelion), the planet is 147,098,074 km, or 0.98 AU. At the farthest point from the Sun (or aphelion) is 152,097,701 km or 1.02 AU.

	Moon		Sun	
	At perigee (nearest)	At apogee (farthest)	At perihelion (nearest)	At aphelion (farthest)
Mean radius	1,737.10 kilometres (1,079.38 miles)		696,000 kilometres (432,000 miles)	
Distance	363,104 km (225,622 mi)	405,696 km (252,088 mi)	147,098,070 km (91,402,500 mi)	152,097,700 km (94,509,100 mi)
Angular diameter	33' 30" (0.5583°)	29' 26" (0.4905°)	32' 42" (0.5450°)	31' 36" (0.5267°)
Apparent size to scale				

SOLAR SCOPE WITH SUN TRACKING UNIT

8. Solar eclipse

As seen from the Earth, a solar eclipse occurs when the Moon passes between the Sun and Earth, and the Moon fully or partially blocks ("occults") the Sun. This can happen only at new moon, when the Sun and the Moon are in conjunction as seen from Earth in an alignment. In a total eclipse, the disk of the Sun is fully obscured by the Moon. In partial and annular eclipses, only part of the Sun is obscured.



A Total eclipse in the umbra.

B Annular eclipse in the antumbra.

C Partial eclipse in the penumbra

9. Transit of planet

A transit of planet across the Sun takes place when the planet passes directly between the Sun and Earth, becoming visible against the solar disc (and hence obscuring a small portion of it). During a transit, planet can be seen from Earth as a small black disc moving across the face of the Sun. The duration of such transit is usually measured in hours. A transit is similar to a solar eclipse by the Moon.

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Astronomy and Astrophysics Experiment Set up

Model No: HO-ED-AP-04

HOLMARC ASTRO SKY VIEW 900F REFRACTIVE TELESCOPE

In this experiment setup for optical astronomy, we use high resolution telescope, digital photometer and charge-coupled devices (CCDs). Main observations are in the range of 400nm to 700 nm wavelength. The same equipment can as well be used to observe near-ultraviolet and near-infrared radiation.

Experiments are designed for observational practice of celestial objects by using telescope and other astronomical measuring apparatus. The study of astronomy with direct experiments is not always feasible, as properties of distant universe are mostly unknown. However, this is partly compensated by the fact that astronomers have a vast number of visible examples of stellar phenomena that can be examined. This allows observational data to be plotted on graphs and general trends recorded. Nearby examples of specific phenomena, such as variable stars, can be used to infer the behavior of more distant representatives. Those distant yardsticks can then be employed to measure other phenomena in that neighborhood, including the distance to a galaxy.

A variety of data can be observed for each object. The position coordinates locate the object on the sky using the techniques of spherical astronomy, and the magnitude determines its brightness as seen from the Earth. The relative brightness in different parts of the spectrum yields information about the temperature and physics of the object. Photographs of the spectra allow the chemistry of the object to be examined.

Features:

- BV photometry
- Magnitude measurements
- Stellar spectrum study
- Variable star measurements
- Atmospheric extinction study
- Temperature measurements of stars
- Night sky brightness measurements

TELESCOPES

RECOMMENDED HOLMARC NEWTONIAN REFLECTIVE TELESCOPES FOR STELLAR MEASUREMENTS

★★★

Model : HO-AAP-SV315 REFLECTIVE TELESCOPES

300mm Dia 1500mm FL Automated Newtonian Telescope
Optics : High performance diffraction free optics
Coating : Metallic Aluminium Coating with SiO over coat for durability
Movement : Motorized Horizontal and vertical scanning
Additional Fetaures : Filter wheel with ND Filters, Colour filter holder, Laser guiding unit for LIDAR up gradation
and star spotting (DPSS Laser), Scanning Software with software development kit (Visual C++ [MatLAB and LAB
View Command can be executed]) etc.

★★★★

Model : HO-AAP-SV418 REFLECTIVE TELESCOPES

400mm Dia 1800mm FL Automated Newtonian Telescope
Optics : High performance diffraction free optics
Coating : Metallic Aluminium Coating with SiO over coat for durability
Movement : Motorized Horizontal and vertical scanning
Additional Fetaures : Filter wheel with ND Filters, Colour filter holder, Laser guiding unit for LIDAR up gradation
and star spotting (DPSS Laser), Scanning Software with software development kit (Visual C++ [MatLAB and LAB
View Command can be executed]) etc.

★★★★★

Model : HO-AAP-SV522 REFLECTIVE TELESCOPES

500mm Dia 2200mm FL Automated Newtonian Telescope
Optics : High performance diffraction free optics
Coating : Metallic Aluminium Coating with SiO over coat for durability
Movement : Motorized Horizontal and vertical scanning
Additional Fetaures : Filter wheel with ND Filters, Colour filter holder, Laser guiding unit for LIDAR up gradation
and star spotting (DPSS Laser), Scanning Software with software development kit (Visual C++ [MatLAB and LAB
View Command can be executed]) etc.

A high resolution Solid state stellar photometer is used for the measurement of star temperature, night sky brightness, variable star study etc. It can be directly attached to the telescope. All the electronics, including detector, electrometer amplifier, voltage-to-frequency conversion electronics, and digital display are contained in one easy-to-handle unit . This model Stellar Photometer makes the concept of a "portable observatory" a reality. With the help of a large telescope we can make accurate and meaningful measurements of variable stars. Following experiments can be performed with HO-ED-AAP-SM02.

6.1MP 1.8" COOLED CCD CAMERA

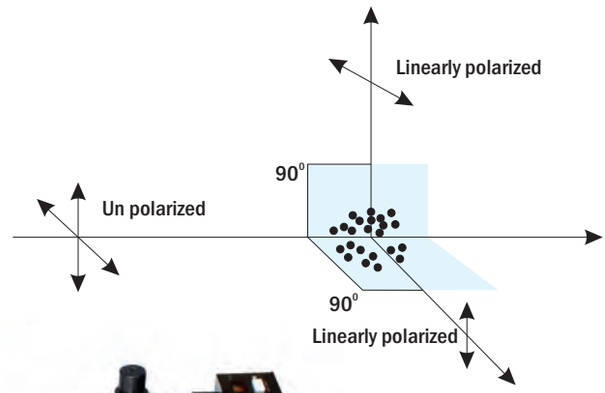
SOLID-STATE STELLAR PHOTOMETER

Experiment Examples:

- To estimate the temperature of an artificial star by photometry.
- Characteristics study of a CCD camera.
- To study the solar limb darkening effect.
- Polar alignment of an astronomical telescope.
- To estimate the relative magnitude of a group of stars.
- To study the atmospheric extinction for different colors.
- To study the effective temperature of stars by B-V photometry.
- To estimate the night sky brightness with a photometer.
- To estimate the distance to the moon by parallax method.
- To estimate the distance to a Cepheid variable.
- To study the variability of delta Scuti type stars.
- To study the variability of RS CVn binaries.
- Polarization of day/moon light Rayleigh scattering.

Rayleigh Scattering

This experiment explores the way light is scattered by particles and shows the effect of polarization. By focusing the light to a photo detector, we can measure the polarization angle of scattered light accurately. The scattering of light by suspended molecules in water produces linearly polarized light in the plane perpendicular to the incident light. As shown in the figure, if the charges in a molecule are oscillating along the y-axis, it will not radiate along the same axis. Therefore, at 90° from the beam direction, the scattered light is linearly polarized.



Temperature determination of an artificial star by photometry

Color temperature is a characteristic of visible light that has important applications in astrophysics. BV photometric technique is used to determine the temperature of an artificial star (Tungsten Halogen Lamp). BV magnitude for different voltages are taken for the experiment. Color temperature is conventionally stated in the unit of absolute temperature, the kelvin, having the unit symbol K.

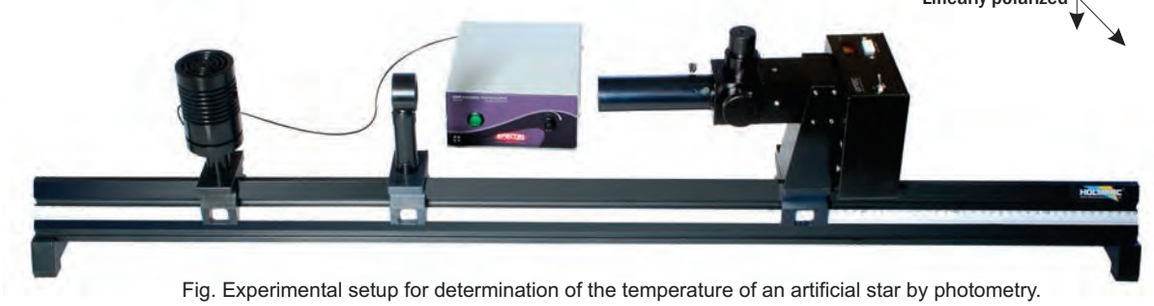


Fig. Experimental setup for determination of the temperature of an artificial star by photometry.

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SOURCES AND DETECTORS

Holmarc manufactures various sources and detectors for conducting experiments in physics and related disciplines. Standard sources and detectors available from Holmarc are listed in this section. More details can be found out in our website www.holmarc.com

01 http://www.holmarc.com/sources_detectors.php

Diode Laser

Holmarc's diode laser module consists of a laser diode along with collimating optics enclosed in a metallic case and a power supply with Automatic Power Control (APC). The laser module has 25mm diameter and 50mm length so that it can be held conveniently in a kinematic or rigid mount. Collimating lens is an aspheric lens with anti-reflection coating. The soft start feature of the power supply assures smooth switch on and long life.

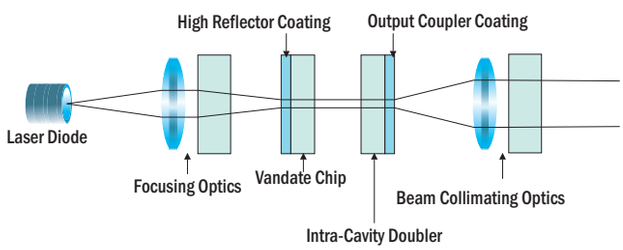
3mW Red diode laser	5mW Red diode laser	5mW Green diode laser
DL-R-3	DL-R-5	DL-G-5
650 nm	650 nm	532 nm

02 http://www.holmarc.com/sources_detectors.php

DPSS Laser

Diode Pumped Solid State (DPSS) lasers are more compact and efficient compared to gas lasers. In DPSS lasers, output emission is achieved by pumping a solid gain medium. Green laser light sources are popular in medical devices and biological research. Green is a primary color and is aesthetically attractive. They exhibit excellent output stability, exceptional mode purity and extremely low power consumption. They are an ideal choice for many laboratory applications.

The power supply and laser head are both compact and light weight. There are mounting holes to facilitate easy mounting to any surface.



Specifications :

Output Power @ 25°C	1~100mW
Operating Current	< 1200mA
Operation Mode	CW 523nm, TEMoo
Line Width	< 0.1nm
Linear Polarization	> 100:1
Beam Diameter (1/e2)	< 1.2mm
Beam Divergence (1/e2, Full Angle)	< 1.5mrad
Power Stability	< 5% (RMS, over 2 hrs)
Point Stability	0.05mrad
Operating Temperature	10°C ~ 30°C
Expected Operating Lifetime	> 5000 hours
Beam Roundness	> 95%

03 http://www.holmarc.com/sources_detectors.php

Lamp Houses

Holmarc offers a number of light sources to cover the spectral range of 200 - 2000nm which can be mounted directly to our monochromators or can be used independently. With appropriate adapters, some of the sources can be mounted to our monochromators along with an optical chopper or filter wheel. Additional adapters and interface kits are available for focusing and launching the light directly into optical fibers.

Lamp Houses for Spectral Study

Sodium Vapor Lamp

Sodium vapor lamp is a gas discharge lamp that uses sodium in an excited state to produce light. The low-pressure sodium lamp has remarkably high luminous efficiency. The radiation is nearly mono-chromatic, yellow in color.

Model No: HO-LH-SV

Mercury Vapor Lamp

mercury-vapor lamp is a gas discharge lamp that uses mercury in an excited state to produce light. They offer long life time as well as intense lighting for spectral applications.

Model : HO-LH-MV100W

Multi Spectrum Tube Housing for spectral calibration

Model No: HO-SP-MSTH-06

Holmarc's Multi Spectrum Tube Housing holds six spectrum discharge tubes simultaneously. It can quickly switch from one gas to another without displacing the lamp housing. Power supply is common for all discharge tubes, kept inside the unit.

The gas tubes are permanently enclosed to protect the tubes from breakage. Optical fiber can be directly attached to this unit for fiber optic spectrometers.

04 http://www.holmarc.com/sources_detectors.php

Spectrum Discharge Tubes

Model No: HO - SDT - XX - YY

Filled with spectroscopically pure gases.The Spectrum Discharge tube comes with built-in power supply. Two types of power supplies are available. A fixed output power supply works with only one type of discharge tube. A variable output power supply can be tuned using a voltage adjust knob to work with different types of discharge tubes.

XX - Gas
01 - Argon
02 - Neon
03 - Krypton
04 - Ammonia
05 - Carbon Dioxide
06 - Nitrogen
07 - Oxygen
08 - Mercury vapor
09 - Sulphur
10 - Hydrogen
11 - Helium

YY - Power Supply
FX - Fixed
VR - Variable

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05 http://www.holmarc.com/sources_detectors.php

High Bright LED

Model No: HO-HBL-XY

Special ultra luminous intensity LED's are housed in metallic casing for ease of mounting. The collimating lens in front of the LED helps to get focused beam and increase it's lighting efficiency. As the LED is encased in a metallic capsule, the body acts as a heat sink. Brightness is continuously adjustable. Built-in constant current power supply provides consistent luminosity.

They are ideal for a variety of illumination applications where collimated light is required. Various color options are available.

X - LED power - 1/3 **Y - Color - R / Y / B / G / W**

06 http://www.holmarc.com/sources_detectors.php

Measurement Devices -Detector Output Measurement Unit

Model No: HO-HBL-XY

Detector Output Measurement Unit measures and displays the current flowing through a detector. It is used for the characteristics study of lasers and other light sources.

Specifications :

Measurement range	0 - 199 mA
Resolution	1 mA to 0.1 A
Detector module	PPD-LK-PT
Detector	Everlight PT333-3C
Detector supply	+5 V
Display	3 digit, 7 segment LED
Power input	230V, 50Hz

INSTRUMENTS AND DEVICES

Over years, Holmarc has developed a range of products for a variety of scientific disciplines, most often, as a custom solution. Many of these products have been standardized and are being regularly manufactured. Some of these instruments typically having scattered applications, are described in this section.

01 http://www.holmarc.com/spectroscopy.php

Spectra UV-VIS-NIR Standard Monochromators

Model No: HO-SP-M01S | HO-SP-M03S

Specifications :

Optical path	Czerny - Turner configuration
Wavelength range	200 - 1600 nm
Scanning range	200 - 1100 nm (Default)
Collimating & focusing mirror	50 mm dia, 300 F
Optical grating	1200 l / mm
Grating size	50 x 50 mm
Absolute diffraction efficiency	45 - 65 %
Slit width	0 ~ 3mm continuously adjustable
Resolution	0.1 nm (@ 546nm, 10µm slit width)
Wavelength accuracy	⩽ 0.2 nm
Wavelength repeatability	⩽ 0.1 nm
Stray light	⩽ 10-3
Reciprocal of linear dispersion	2.7 mm
Half-width of spectral line	⩽ 0.2nm @ 586 nm

Holmarc Spectra UV-VIS-INR standard monochromators are designed for general spectroscopic research needs. These monochromators are designed for using single 1200 lines / mm holographic precision grating. A microprocessor onboard controls used for precision wavelength positioning. These can be operated either from the front panel of the instrument or through a personal computer which can be interfaced with the device using RS 232C serial port. The instrument is made user friendly by incorporating LCD display and keyboards. Input and output ports of the monochromator are fitted with precise, micrometer controlled variable slits.

02 http://www.holmarc.com/spectroscopy.php

UV-VIS-NIR Scanning Spectrometer

Model No: HO-SP-S100MA | HO-SP-S100SA

Specifications :

Optical path configuration	Czerny - Turner type
Dispersion element	Holographic grating
Grating density	1200 grooves / mm
Relative diffraction efficiency	45 - 65 % (Visible)
Scanning wavelength range	190 - 1100 nm
Wavelength range (Detector)	350 - 1100 nm (HO-SP-S100SA) 185 - 900 nm (HO-SP-S100MA)
Resolution	0.1 nm
Wavelength repeatability	± 0.5 nm
Slit width	0 - 4mm (Micrometer controlled)
Detector	Si photodiode or PMT
Interface	USB 2.0 or RS-232
Data formats	Spreadsheet

Scanning spectrometer is specially designed and developed for industrial and academic research laboratories in the fields of biology, chemistry, physics, environmental science and engineering. This device works in the wavelength range of 190 to 1100nm. Scanning spectrometer can rapidly scan a range of wavelengths and record light intensity at each wavelength.

This instrument uses a concave mirror to collimate the light from an input port. Input and output ports of the spectrometer are fitted with precise micrometer controlled variable slits. A plane holographic grating is used to diffract the input light that is subsequently focused by a second concave mirror.

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03 http://www.holmarc.com/imaging_measuing_instruments.php

Traveling Microscope

Model No: HO-TM-01

Holmarc offers traveling microscope with three axis measurement possibility, horizontal, vertical and right angled transverse motion. The instrument finds wide applications in general purpose scientific and industrial measurements. It can be used for accurate dimensional measurements of different objects. Other applications include accurate determination of small variation in the liquid levels, determination of refractive index of liquids, surface tension, viscosity etc.

Specifications :

X direction	Micrometer head
Coarse travel	150 mm
Z direction	Micrometer head
Coarse travel	130 mm
Rotation	360 degree (lockable)
Magnification	10 X
Focal length	25 mm
Magnification	3 X
Focal length	60mm

04 http://www.holmarc.com/imaging_measuing_instruments.php

Autocollimator

Model No: HO-OI-AC3

Autocollimator is a versatile non-contact optical instrument for measurement of small angles or tilt movements with very high sensitivity. Holmarc manufactures precision autocollimator as a standard product with Model no. HO-OI-AC3. The instrument finds multitude of applications in shop floor as well as metrology labs for precision measurements of straightness, parallelism, perpendicularity and flatness.

Specifications :

Resolutions	3 arc second
Accuracy	1 arc second
Measurement axis	Dual X Y
Sensitivity	0.5 arc sec.
Range	1 arc min.
Read out	Micrometer
Reticule illumination	LED, green - variable P.S

05 http://www.holmarc.com/imaging_measuing_instruments.php

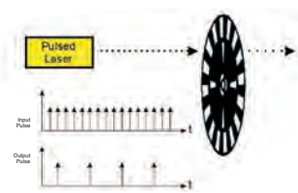
Optical chopper

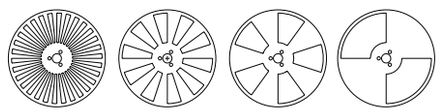
Model No: HO-ID-02

Holmarc's optical chopper is a highly stable device throughout the frequency range. The basic system consists of a control unit, a rotating head and a set of four chopper discs. DC motor drives the rotating head in closed loop control. Chopping discs are replaceable at user end with ease. A heavy base to which the rotating assembly is fixed provides stability during operation. Optical axis height is approximately 100 mm. The required disc depending on the frequency can be fixed to the rotating head.

Specifications :

Frequency	
Two slot	10Hz to 200 Hz
Six slot	200Hz to 1000 Hz
Thirty slot	1000Hz to 4000 Hz
Chopper wheel diameter	105 mm
Frequency read out	16 x 2 line LCD
Reference pick-up	IR LED and Photo - transistor pair
Motor cable length	2 m
Operating temperature	10 - 50°C
Power input	230V, 50Hz





30 Slot Blade | 10 Slot Blade | 5 Slot Blade | 2 Slot Blade

The device can be customized as per requirements. Custom blades can also be manufactured. We welcome queries for customization.

LAB EQUIPMENTS

Holmarc is well equipped in mechatronics with experienced professionals and manufacturing infrastructure. All the lab equipments described in this section are designed, developed and manufactured in house. These products are widely used in laboratories around the world for research in nano-technology, bio-technology and solar cells.

01 http://holmarc.com/lab_equipments.php

Nano Fiber Electrospinning Units from Holmarc

Holmarc's Nano fiber electro spinning units are reliable and efficient systems which have been designed for research laboratories. These are used to make nano and micro fibers ranging from 50nm to 5 microns in diameter. Many types of polymers like Protein nanofibers, carbon nanotubes, inorganic nanofibers etc. can be synthesized using our nano fiber electrospinning units. Its user friendly software, task oriented design, ease of operation and competitive pricing are certain features that place this equipment ahead of other products available in the market.

HO-SPLF4 model syringe pump renders a smooth and uninterrupted flow enabling uniform spinning. HMPSKV30 model high voltage power supply delivers 0-30 KV output voltage range with a maximum current capacity of 0.5 mA. A stationary target, XY axis moving target and rotating mandrels of six different diameters are supplied along with the unit. Apart from these, Holmarc also provides other optional accessories such as UV curing lamp, co-axial spinneret etc as per customers' requirements. Dedicated earthing, inbuilt emergency stop button and residual charge discharge stick are provided for the sake of safety.

HO-FH-01 model fume hood provides an enclosed atmosphere with transparent side walls to monitor the electro spinning process. The hood also has features like exhaust fan, granite work surface and optional features like high bright halogen lighting, duct of custom dimension etc.

Holmarc manufacture Nano fiber Electrospinning equipments in FIVE models as described below:

Nano fiber Electrospinning Unit - Base Model

Model No: HO-NFES-040D

Holmarc's (Model No: HO-NFES-040D) Electro-spinning equipment is an entry level system for producing Nanofibers in laboratories. This model of Nano fiber Electrospinning Unit is upgradable.

Specifications

Syringe Dispenser	Single Syringe pump
Flow rate	2.8µl/hr - 19ml/min
Stationary Plate collector	320 mm X 100 mm x2mm
XY Plate collector	300 mm X 200 mm x5mm
Rotating mandrel	Length=200 mm(Diameter=100, 75,25,12,6,2 mm)
Rotational speed	300 - 4000 RPM
Spinning direction	Horizontal
H.V. Power Supply	0-30 KV, max Current 0.5mA
Foot Print	1000 X800 X 1672 mm

This Nano fiber Electrospinning Unit - Base Model can be upgradable.For more detail please contact us

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02 http://holmarc.com/lab_equipments.php

Compact Nano fiber Electrospinning Unit with Support

Model No: HO-NFES-040B

Holmarc's HO-NFES-040B model Electro-spinning equipment is a compact version for Nano fiber Electro spinning. A unique support structure made of steel pipes is provided along with the equipment which when screwed and fixed together can be used as a sturdy support for the Nano fiber electrospinning unit.

Specifications

Syringe Dispenser	Independently Controlled Dual Channel Syringe Pump
Flow rate	2.8µl/hr - 19ml/min
Max. no of syringes	4
Stationary Plate collector	320 mm X 100 mm x2mm
XY Plate collector	300 mm X 200 mm x5mm
Rotating mandrel	Length=200 mm(Diameter=100, 75,25,12,6,2 mm)
Rotational speed	300 - 4000 RPM
Spinning direction	Horizontal
H.V. Power Supply	0-30 KV, max Current 0.5mA
Foot Print	1000 X800 X 1672 mm
Weight (appx.)	455 Kg

03 http://holmarc.com/lab_equipments.php

Nano Fiber Electrospinning Unit - Floor Stand Unit

Model No: HO-NFES-040

This model of nano fiber electrospinning unit is a floor stand version. The floor stand feature provides a bottom shelf section for accessories storage.

Specifications

Syringe Dispenser	Independently Controlled Dual Channel Syringe Pump
Flow rate	2.8µl/hr - 19ml/min
Max. no of syringes	4
Stationary Plate collector	320 mm X 100 mm x2mm
XY Plate collector	300 mm X 200 mm x5mm
Rotating mandrel	Length=200 mm(Diameter=100, 75,25,12,6,2 mm)
Rotational speed	300 - 4000 RPM
Spinning direction	Horizontal
H.V. Power Supply	0-30 KV, max Current 0.5mA
Temperature	Upto 50°C using 1000 watt heater
Foot Print	1200 X800 X 1750 mm
Weight (appx.)	551 Kg

04 http://holmarc.com/lab_equipments.php

Dual Pump Nano Fiber Electrospinning Unit

Model No: HO-NFES-043C

Holmarc's (HO-NFES-043C model) Electro-spinning equipment features two syringe pumps on both sides of the rotating mandrel. The distance between the syringe and drum can be adjusted. The speed, travel and dispensing rate can be changed on both syringe pumps. This technique helps the end user to increase the production rate of nano fibers. Two different materials can be spun simultaneously, if required, using this unit.

Specifications

Syringe Dispenser	Independently Controlled Dual Channel Syringe Pump
Flow rate	2.8µl/hr - 19ml/min
Max. no of syringes	4(Each for two syringe pumps)
Stationary Plate collector	320 mm X 100 mm x2mm
XY Plate collector	300 mm X 200 mm x5mm
Rotating mandrel	Length=200 mm(Diameter=100, 75,25,12,6,2 mm)
Rotational speed	300 - 4000 RPM
Spinning direction	Horizontal
H.V. Power Supply	0-30 KV, max Current 0.5mA
Foot Print	1700mm x 800mm x 1672 mm
Weight (appx.)	622 Kg

05 http://holmarc.com/lab_equipments.php

Nano Fiber Electrospinning Unit with Horizontal & Vertical Spinning

Model No: HO-NFES-043

Holmarc's Model HO-NFES-043 facilitates motorized XY movement for the needle tip. The needle tip can be arranged in horizontal or vertical fashion for spinning. Collector bowl for liquid targets is also provided along with the system. The Flat tipped metal needles are also provided for the easy flow of the nano fibers. High voltage is connected to the tip of the needle using metal clips. It equips coaxial spinneret which helps to produce hollow nanofibers and core / sheath nanofibers. This technology can also be used to combine different characteristics of each polymer into one fiber.

Specifications

Syringe Dispenser	Independently Controlled Dual Channel Syringe Pump
Flow rate	2.8µl/hr - 19ml/min
Max. no of syringes	4
Stationary Plate collector	320 mm X 100 mm x2mm
XY Plate collector	300 mm X 200 mm x5mm
Rotating mandrel	Length=200 mm(Diameter=100, 75,25,12,6,2 mm)
Rotational speed	300 - 4000 RPM
Spinning direction	Horizontal & Vertical
H.V. Power Supply	0-30 KV, max Current 0.5mA
Foot Print	1000mm x 800mm x 1672 mm
Weight (appx.)	420 Kg

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06 http://holmarc.com/lab_equipments.php

Flame assisted spray pyrolysis equipment

Model No: HO-TH-O4FA

Holmarc's Flame Assisted Spray Pyrolysis Equipment Model : HO-TH-04FA has been developed for research in surface quality improvement of metallic alloys and ceramics. In this technique, solution is sprayed on to a heated substrate through an oxygen-acetylene flame. The equipment is fitted with accessories required for controlling the flame during the process. The solution is spayed using a positive displacement pump and compressed air through a mixing chamber and nozzle. The substrate is placed on a hot plate, temperature of which can be set at the desired level through a dedicated controller.

Specifications

Actuator	Stepper motor
Dispensing unit capacity	50ml & 250ml
Dispensing rate	1 - 20ml/min.
Sprayer	
Drive speed X axis (min-max)	5 - 20mm/sec
Drive speed Y axis (min-max)	2 - 12mm/sec
Sprayer traverse	X - Y 250mm max.
Substrate base plate	
Dimension	150 x 150mm
Max. temperature	500°C
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)

07 http://holmarc.com/lab_equipments.php

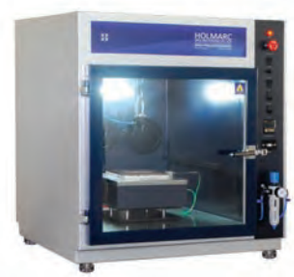
Spray pyrolysis equipment (Table top model)

Model No: HO-TH-O4BT

HOLMARC's Spary Pyrolisis Equipment (Table Top) Model :HO-TH-04 BT is more compact and sleek model that does not take too much space in your laboratory. It can be placed in any available platform. Even though smaller in size it performs all the functions and operations of the standard model. Holmarc's Spray Pyrolysis System has been designed for research laboratories in thin films, especially for solar cell development. The system automates various fatigue and error creating processes involved in the technique when performed manually. Moreover, ergonomically designed chamber provides clean and healthy atmosphere suitable for modern lab conditions.

Specifications

Actuator	Stepper motor
Dispensing unit capacity	50ml & 250ml
Dispensing rate	1 - 10ml/min.
Sprayer	
Drive speed X axis (min-max)	10 - 800mm/sec
Drive speed Y axis (min-max)	1 - 12mm/sec
Sprayer traverse	X - Y 200mm max.
Substrate base plate	
Dimension	150 x 150mm
Max. temperature	500°C
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)



08 http://holmarc.com/lab_equipments.php

Spray pyrolysis equipment

Model No: HO-TH-O4

Holmarc's Spray Pyrolysis system has been designed for research laboratories in thin films, especially for solar cell development. The system automates various fatigue and error creating processes involved in the technique when performed manually. Moreover, ergonomically designed chamber provides clean and healthy atmosphere suitable for modern lab conditions.

Specifications

Actuator	Stepper motor
Dispensing unit capacity	50ml & 250ml
Dispensing rate	1 - 20ml/min.
Sprayer	
Drive speed X axis (min-max)	10 - 800mm/sec
Drive speed Y axis (min-max)	1 - 12mm/sec
Sprayer traverse	X - Y 200mm max.
Substrate base plate	
Dimension	150 x 150mm
Max. temperature	500°C
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)

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Spray pyrolysis equipment(Larger version)

Model No: HO-TH-O4A

This is the latest model in Holmarc's line of Spray Pyrolysis Units. This model is the larger version of the standard model that provides expanded capacity and increased travel area for the spray head. This also provides a larger heating platform to spray coat substrates that are larger than standard application. This model uses a fresh new design that enables the user to carry out the spray coating process in a more convenient and efficient manner. This model can also be separated from the bottom shelf section for use as a table top unit. This unit also provides for Nitrogen purging of the enclosure.

Specifications

Actuator	Stepper motor
Dispensing unit capacity	50ml & 250ml
Dispensing rate	1 - 20ml/min.
Sprayer	
Drive speed X axis (min-max)	10 - 800mm/sec
Drive speed Y axis (min-max)	1 - 12mm/sec
Sprayer traverse	X - Y 250mm max.
Substrate base plate	
Dimension	250 x 250mm
Max. temperature	500°C
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)

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Vacuum Spray Pyrolysis Automated Equipment

Model No: HO-TH-VSP-500T

Holmarc's Vacuum Spray Pyrolysis (VSP) system has been designed for advanced research in thin films, especially for solar cell development. This model facilitates the spray pyrolysis to take place in an inert atmosphere using Nitrogen purging. This model comes with a metal (Tin) bath heater instead of regular stainless steel hot plate. This provides uniform and stable heating to the substrate during the coating process. The system automates various fatigue and error creating processes involved in the technique when performed manually. Moreover, ergonomically designed chamber provides clean and healthy atmosphere suitable for modern lab conditions.

Specifications

Coating Chamber - Chamber Size 700x700x800mm
Chamber Consists of , water cooling lines, nitrogen inlet port , overhead feed through, Illumination unit with a vacuum vew port etc.
Material construction SS304
Vacuum Pump ..... Oil vacuum pump
Substrate Size 100x100mm
Operation ..... 500 - 600 millibar
Inert Gas Operation ..... Nitrogen purging
Heater Size ..... 150x150mm, with Tin bath, heat range 500 C
Dispensing System ..... Stepper motor controlled syringe pump
Dispensing unit capacity ..... 50ml & 250ml
Dispensing rate ..... 1 - 10ml / min.
Drive speed X axis (min-max) ..... 10 - 800mm/sec
Drive speed Y axis (min-max) ..... 1 - 12mm/sec
Sprayer traverse ..... X - Y 200mm max.

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Silar coating system

Model No: HO-TH-03

Holmarc's SILAR Coating System has been designed to automate the entire process to avoid operator fatigue and errors associated with it. In manual SILAR process, the operator has to perform hundreds of repetitive dipping into the solution and water. It is very difficult to control dip duration and number of dips in a manual process, which can last hours.

Specifications

Actuator	Stepper motor
Drive mechanism	Lead screw
Dip duration	0 - 99 sec / min / hr
Number of dips	1 - 999
Operating temperature	Ambient to 80
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)
Stroke length	75mm

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SILAR Coating System with Stirrer

Model No: HO-TH-O3A

This model: HO-TH-03A has a motorized substrate holder which can be used to stir the solution. By rotating the substrate along with the holder at desired speed, the solution can be kept stirred during the dipping process. The rotation speed is programmable from 2 - 200 rpm. The dipping speed, dip duration, retrieval speed and dry duration can be set for each beaker. Each hot plate can be set at different temperatures. The temperature can be set up to 350°C from ambient.

Specifications

Actuator	Stepper motor
Drive mechanism	Lead screw
Dip duration	0 - 99 seconds/minutes/hours
Number of dips	1 - 999
Hot plate temperature	Ambient to 350°C
Stirrer speed	2 - 200 rpm
PC connectivity	Serial port (RS 232)
Stroke length	75mm
Power input	230V, 50Hz

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SILAR Coating System with Stirrer 8

Model No: HO-TH-O3A8

This model: HO-TH-03A8 has a motorized substrate holder which can be used to stir the solution. In this model eight beakers placed in a circular arrangement about the rotation axis of sample dipping arm. There will be heating plate for each of the beakers. Maximum diameter of hot plate surface on each of these 8 positions will be three inches. By rotating the substrate along with the holder at desired speed, the solution can be kept stirred during the dipping process.

Specifications

Actuator	Stepper motor
Drive mechanism	Lead screw
Dip duration	0 - 99 seconds / minutes / hours
Number of dips	1 - 999 (Increment by 1 cycle should be possible)
Hot plate temperature	Ambient to 350°C
Stirrer speed	Adjustable 2rpm - 200 rpm
PC connectivity	Serial port (RS 232)
Power input	230V, 50Hz
No. of position for beakers	8
No. of samples could be loaded	5
No. of programs	5

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SILAR Coating System with Stirrer S

Model No: HO-TH-O3S

Holmarc's SILAR Controller with Stirrer, Model: HO-TH-03S has a motorized substrate holder which can be used to stir the solution. By rotating the substrate along with the holder at desired speed, the solution can be kept stirred during the dipping process. The rotation speed is programmable from 2 - 200 rpm. The dipping speed, dip duration, retrieval speed and dry duration can be set for each beaker. There is a heater and temperature controller, common for 6 beakers and the temperature can be set up to 80°C from ambient. The device is compact and complete with a footprint of 376 x 330 mm.

Specifications

Actuator	Stepper motor
Drive mechanism	Lead screw
Dip duration	0 - 99 seconds / minutes / hours
Number of dips	1 - 999
Operating temperature	Ambient to 80°C
PC connectivity	Serial port (RS 232)
Stroke length	75 mm
Rotary speed	0 - 60 deg / sec
Drawing speed	200 micron/sec - 16mm/sec (Manual mode) 2 - 16000 micron/sec (PC mode)
Stirrer speed	2 - 200 rpm

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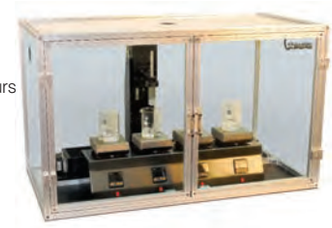
SILAR Coating System with Magnetic Stirrer

Model No: HO-TH-O3B

In the Model HO-TH-03B the solution containing beakers are kept on hot plates with magnetic stirrers. The rotation speed of the stirrers can be controlled from 1 - 1000 rpm. The dipping speed, dip duration, retrieval speed and dry duration can be set for each beaker. Each hot plate can be set at different temperatures. The temperature can be set up to 200°C from ambient.

Specifications :

Actuator	Stepper motor
Drive mechanism	Lead screw
Dip duration	0 - 99 seconds / minutes / hours
Number of dips	1 - 999
Hot plate temperature	Ambient to 200°C
Stirrer speed	0 -999 rpm
PC connectivity	Serial port (RS 232)
Stroke length	100mm
Power input	230V, 50Hz



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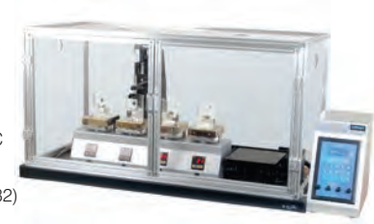
Silar Coating System with Magnetic Stirrer & Ultrasonic Bath Stand

Model No: HO-TH-O3C

This model has magnetic stirrers which can be used to stir the solution. The rotation speed can be controlled from 2 - 200 rpm. The dipping speed, dip duration, retrieval speed and dry duration can be set for each beaker. Each hot plate can be set at different temperatures. The temperature can be set up to 200°C from ambient. There is a fifth stand in this model for keeping an ultrasonic bath.

Specifications :

Actuator	Stepper motor
Drive mechanism	Lead screw
Dip duration	0 - 99 (seconds / minutes / hours
Number of dips	1 - 999
Hot plate temperature	Ambient to 200°C
Stirrer speed	0 -999 rpm
PC connectivity	Serial port (RS 232)
Stroke length	100mm
Power input	230V, 50Hz



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Silar Coating System with Magnetic Stirrer & Air-tight Chamber

Model No: HO-TH-O3BV

Holmarc's SILAR coating system with Magnetic stirrer and Air-tight Chamber (Model No: HO-TH-03BV) features an air-tight chamber with a service window and an operating window. The unit provides inlet and outlet valves for inert gas purging. This helps to protect samples from moisture or oxygen exposure at the end of the coating process. It provides four separate platforms to place coating solutions each with magnetic stirrer. User can also control the speed of the magnetic stirrer for each beaker independently by using the knobs on the front panel of the controller.

Specifications :

Actuator	Stepper motor
Drive mechanism	Lead screw
Dip duration	0 - 99 seconds / minutes / hours
Number of dips	1 - 999
Stirrer speed	0 -999 rpm
PC connectivity	Serial port (RS 232)
Stroke length	100mm
Power input	230V, 50Hz
Air tight chamber	Available

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SILAR system without heater and stirrer

Model No: HO-TH-O3D

One of the contemporary method for the deposition of thin film is Successive Ionic Layer Adsorption and Reaction (SILAR) method, which is also known as modified version of chemical bath deposition. As it is a chemical method, a large number of varieties of substrates can be coated.Holmarc's SILAR Coating System has been designed to automate the entire process to avoid operator fatigue and errors associated with it.

Specifications :

Mode of operation	Manual (LCD)
Actuator	Stepper Motor
Drive Mechanism	Lead screw
Dip duration	0 - 99 sec / min / hour
No. of dips	1 - 999
PC Connectivity	RS 232
Stroke length	75 mm
Power input	230V, 50Hz
No. of position for beakers	4
No. of samples could be loaded	5
Platform to keep beakers	Not required.
Dip min. / max. speed	2 microns / sec - 9000 microns / sec
Retrieval min. / max. speed	2 microns / sec - 9000 microns / sec

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Dip Coating Unit

Model No: HO-TH-O1

Holmarc's Dip Coating Unit has been designed to keep operator involvement as minimum as possible so that variables like speed, duration, etc. are maintained accurately by computer control. Movements are achieved by a precision servo motor controlled linear stage.Dip-coating process, includes five stages: immersion, start-up, deposition, evaporation and drainage. In the dip coating method, the substrate is slowly dipped into and withdrawn from a tank containing the solution, with a uniform velocity, in order to obtain a uniform coating.

Specifications :

Actuator	Servo motor
Drive mechanism	Lead screw
Speed control	Available
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)
Stroke length (max)	150mm
Drawing speed min.	2 micron/sec
Drawing speed max.	9000 micron/sec
Dimensions (appx.)	200 x 150 x 380mm

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Multiple Dip Coater

Model No: HO-TH-O2MD

Holmarc's Multiple Dip Coater (Model No: HO-TH-02MD) comes with six beaker holders and provision to mount a high temperature furnace. A quartz tube furnace can be mounted vertically and its temperature can be set up to 1200°C. The substrate holder is made of Molybdenum to withstand the high temperature. The dip-coating solution and the furnace are positioned in a circle about a rotating arm of the dip coater. Hence, it is possible to coat different solutions alternatively, with heating in furnace in between them.

Specifications :

Actuator	Servo motor
Drive mechanism	Lead screw
Speed control	Available
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)
Stroke length max.	200 mm(in furnace)
Drawing speed min.	2 micron/sec
Drawing speed max.	2 micron /sec - 9mm /sec
Dimensions (appx.)	580 x 600 x 580 mm H
Weight (appx.)	45 kg

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Angle Dependent Dip Coating Unit

Model No: HO-TH-ADDC1

Holmarc's Angle Dependant Dip Coating unit enables nano layer coating of substrates by dipping them in beakers containing coating solution. The dipping angle can be varied from 0 to 45 degree depending upon the requirement. There are 4 beaker holders provided for coating 4 different substrates. The dipping speed, dip duration, withdrawal speed and dry duration can be varied for each beaker independently. The substrate is drawn out of the coating solution under a well defined angle of inclination.

Specifications :

Actuator	Servo motor
Drive mechanism	Lead screw
Speed control	Available
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)
Stroke length max.	75 mm
Drawing speed min.	2 micron/sec
Drawing speed max.	9000 micron/sec
Dimensions (appx.)	570 x 300 x 475 mm
Program memory	8 Programs
max. power consumption	800 Watts

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Dip Coating Unit with Hot Chamber

Model No: HO-TH-O2

In Holmarc's Dip Coating Unit Model:HO-TH-02, the substrate is dipped in the solution and then withdrawn into a heating chamber. Temperature of the chamber can be controlled and fixed up to 75°C from ambient. All other features are same as that of Model: HO-TH-01.The system has a user friendly front panel with key board and LCD display. It can as well be controlled through a computer. Dip duration, dip speed, baking duration, withdrawal speed etc. are programable features. Servo motor is used as actuator for vibration free dipping and withdrawal.

Specifications

Actuator	Servo motor
Drive mechanism	Lead screw
Speed control	6 step variable speed(PCMode)
Power input	230V, 50Hz
PC connectivity	Serial port (RS232)
Stroke length max.	150 mm
Drawing speed min.	2 micron /sec
Drawing speed max.	9000 micron / sec
Dimensions (appx.)	630x 348 x 416 mm
Program memory	5 Programs
Max. power consumption	460Watts

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Dip Coating Unit with Infrared Dryer

Model No: HO-TH-O2B

HOLMARC's Dip coating unit with infrared dryer (HO-TH-02B) has an infrared dryer incorporated with it. This is meant for drying the substrate after the coating has been made. It has an infrared bulb inside, whose temperature can be set to a maximum of 200°C from ambient. The infrared dryer provides uniform heating to the substrate. The temperature is swiftly attained so that the time taken for the dipping process is greatly reduced.

Specifications

Actuator	Servo motor
Drive mechanism	Lead screw
Speed control	Available
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)
Stroke length max.	150 mm
Drawing speed min.	2 micron/sec
Drawing speed max.	9000 micron/sec
Program memory	5 programs
Dimension	630 x 368 x 420 mm
Max. Power Consumption	600 watts
Max Temperature	200° Celsius
Max Substrate size	75 mm x 25 mm

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Dip Coating Unit with Touch Screen Interface

Model No: HO-TH-O1T

Holmarc's Dip Coating Unit with Touch screen Interface delivers an optimized performance and smart technology. Model: HO-TH-01T, features 4.5 inch LED touch screen display . A user can easily input or control all the process parameters through simple or multi-touch gestures by touching the screen. The touch screen enables the user to interact directly with what is displayed, rather than using a keypad. Moreover it can be controlled through a computer. All other features are same as that of Model: HO-TH-01.

Specifications

Actuator	Servo motor
Drive mechanism	Lead screw
Speed control	Available
Power input	230V, 50Hz
PC connectivity	USB Interface
Stroke length max.	150 mm
Drawing speed	2 micron/sec - 9mm/sec
Dip duration	0-99 seconds / minutes / hours
Max. no.of repetitive dips	1 - 999
Interface	4.5 inch LED Touch screen
Dimensions (appx.)	368 x 420 x 512 mm
Weight (appx.)	40 Kg

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Spin Coating Unit

Model No: HO-TH-O5

Holmarc's Spin Coater, Model no: HO-TH-05 is a dedicated tabletop system to spin coat small substrates in research laboratories with well controlled spin process parameters. The spin head actuator is a precision DC servo motor with accurate speed and acceleration control. A vacuum chuck powered by oil-less vacuum pump holds the substrate at the spinning head.The device has user friendly front panel having keyboard and LCD for programming the spin process. Spin duration, spin speed, acceleration, etc. are all programmable parameters through the front panel.

Specifications

Actuator	Brushless DC motor
Spinning speed	60 - 9999 rpm
Substrate diameter	30 mm to 70 mm
Power input	230V, 50Hz
Read out	20 x 4 line LCD
Spin chamber	Nylon
Acceleration	5 - 2000 rpm / sec
Spinning Speed Accuracy	< 5%
Programmable parameters	Speed,acceleration, dwell time and no. of steps
Maximum no of steps	9
Program memory	9 programs (non – volatile)
Dimension	400mm Depth x 275mm W x 500mm H
Weight (appx.)	34 Kg

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Spin Coating Unit with UV curing system

Model No: HO-TH-O5C

Holmarc's Spin Coating unit, Model no: HO-TH-05C has been designed with many additional features than that of Model: HO-TH-05.In this model of spin coater, UV LED curing system is used whenever there is a need for curing and drying of coatings. It also provides gases purge facility for additional supply of gases inside the chamber. Vaccum Chucks provide flat, rigid surface for mounting substrates of different sizes and shapes. There is an adaptor to fix petri dishes of sizes ranging from 30 mm to 100 mm diameter. A vaccum chuck powered by oil- less vaccum pump holds the substrate at the spinning head.

Actuator	Brushless DC motor
Spinning speed	60 - 9999 rpm
Substrate diameter	30 mm to 70 mm
Power input	230V, 50Hz
Read out	20 x 4 line LCD
Spin chamber	Nylon
Acceleration	5 - 2000 rpm / sec
Spinning Speed Accuracy	< 5%
Programmable parameters	Speed, acceleration, dwell time and no. of steps
Maximum no of steps	9
Program memory	9 programs (non – volatile)
Dimension	400mm Depth x 275mm W x 500mm H
LED Wavelength	405 nm

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Ion Exchanger

Model No: HO-TH-O6

Holmarc's Ion exchanger, is a dedicated device for forming thin films by dipping the substrate in melt kept in hot chamber. Temperature of the heater can be controlled and fixed up to 400°C from ambient. Speed, duration, etc. are maintained accurately by computer control. Movements are achieved by a precision servo / stepper motor controlled linear stage.The system has a user friendly front panel with key board and LCD display. It can as well be controlled through a computer.

Specifications

Actuator	Stepper motor (Servo - Optional)
Drive mechanism	Precision rolled ball screw
Speed control	Available
Power input	230V, 50Hz
PC connectivity	Serial port (RS 232)
Stroke length max	150mm
Drawing speed min.	2 micron/sec
Drawing speed max.	9000 micron/sec

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Bench Top Rubbing Machine

Model No: HO-IAD-BTR-01

Rubbing Machine has been developed for LCD R&D Labs. The system is intended for tracing grooves on the substrate to orient the liquid crystal molecules. The grooves are made using a special rubbing cloth having depth of a few angstrom. The substrate is held by a vacuum chuck for which a vacuum pump is included and integrated with the system. Maximum size of glass substrate which can be loaded is 100 mm x 100mm. The substrate along with vacuum chuck is held on a rotation stage so that it can be rotated and positioned at any required angle from 0 to 180 degrees for various rubbing orientations.

Programmable Features

- Movement range for the substrate
- Speed of movement (substrate stage)
- No. of repetitions / duration of operation

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Bench Top Rubbing Machine

Model No: HO-IAD-BTR-02

Rubbing Machine has been developed for LCD R&D Labs. The system is intended for tracing grooves on the polyimide to orient the liquid crystal molecules. The grooves are made using a special rubbing cloth having depth of a few angstrom. The substrate is held by a vacuum chuck for which a vacuum pump is included and integrated with the system. Maximum size of glass substrate which can be loaded in Model: HO-IAD-BTR-02 is 200mm diameter. The substrate along with vacuum chuck is held on a rotation stage so that it can be rotated and positioned at any required angle from ±20 degrees for various rubbing orientations.

Programmable Features

- Tilting Adjustments for leveling the substrate.
- Vertical stage for adjusting the height.
- Vaccum release button

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Syringe Pump / Infusion Pump

Model No: SPLF 2D | SPLF 4

Holmarc's SPLF series syringe pumps are versatile and cost effective products for precise dispensing of fluids in laboratory experiments. The pump can operate with standard off the shelf syringes in plastic, glass and stainless steel. The dispensing rates / flow rates possible with the device are very wide in range and can vary from 2.8 micro-l/hr to 19ml/min.

Features

- Operates in stand alone or through a personal computer
- Microprocessor controlled mechanism
- Front panel with keyboard and display for programming
- Silent and smooth operation
- Compatible with glass, plastic and SS syringes

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Peristaltic Pump

Model No: HO-LS-PP-01, 02, 04, 06

Holmarc offers wide range of peristaltic pumps for dispensing, filling, dosing, sampling and transferring applications. The advantage of using peristaltic pump is that no contamination will occur to the fluid or to the pump. To use a different fluid, all you need to do is to change the tubing used to pump the fluid.

Features

- Variable speed drive
- Contamination free pumping
- No reverse flow or back flow
- Accurate and repeatable flow rate
- Instant start or stop facility
- Complete isolation of pumped fluid
- Ergonomic design, ease to use
- Almost maintenance free
- Clear, easily read LCD illuminated display
- Stepper motor used for driving the system

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Digital Magnetic Stirrer

Model No: HO-MS-01

Holmarc's Digital Magnetic Stirrer is a state of the art device that provides an extra degree of precision for your applications in research and other activities. A magnetic stirrer is a laboratory device that employs a rotating magnetic field to cause a Teflon coated steel bar immersed in a liquid to spin very quickly, thus stirring it. It is an essential tool for research labs.

Features

- Compact and User friendly device
- Fully digital console with LCD and keyboard
- Microprocessor controlled operation
- Maximum rpm of 1500
- Multiple programs with multiple steps with independent durations

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Digital Magnetic Stirrer with hot plate

Model No: HO-MS-02

Holmarc Digital Magnetic Stirrer with hot plate combines stylish design and functionality in a compact device. Its user friendly keyboard and LCD display can be used to input required programs and parameters. The unit has inbuilt software with capabilities of storing multiple programs. The microprocessor controlled unit makes sure smooth and silent operation. We can input the required speeds on the digital consol and view instantaneous changes on the display

Features

- Compact and User friendly device
- Fully digital console with LCD and keyboard
- Microprocessor controlled operation
- Maximum rpm of 1500
- Multiple programs with multiple steps and independent durations
- Heating platform - 200°C (different models are available)

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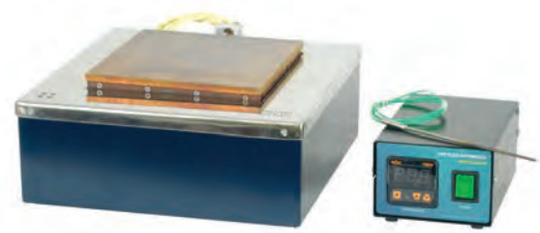
Hot Plate

Model No: HO-HPC-01



Holmarc Hot Plate features rugged SS surface which provides uniform heat distribution and resists corrosion. The controller, which is placed remotely, facilitates microprocessor-controlled feedback which maintains consistent, repeatable temperature settings which is ideal for repetitive procedures.

Temperature can be adjusted from ambient up to 500°C. K type thermocouple temperature sensor is included in the Hot plate for accurate temperature measurements. The equipment is avaliable in two plate dimensions : 250 X 250 mm & 150 X 150 mm. Depending on the region of use, two power options are also avaliable for the Hotplate. 110 V & 220V AC

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Single Channel Dispensing Station

Model No: HO-BL-SCDS-214P

Holmarc's single channel dispensing station (Model : HO-BL-SCDS-214P) automates repetitive dispensing of liquids in to bottles or containers in the pre determined quantities. The system consist of a peristaltic pump, conveyor belt for positioning of bottler in x axis, two axis positioning (Y & Z) for dispensing nozzle and stand alone controllers with user interface integrated in the system. Use of peristaltic pump with easily replaceable tubes prevent contamination as the pump liquid do not touch any of the pump parts except the tubing.

Specifications

Type	Single channel dispensing
Feeding	Motorized conveyer system
Feeding tray size	Standard, 96 well plate
Dispensing	Peristaltic pump
Flow rates	0-1 to 5 ml / min
Motor	Stepper motor
Power supply	220 - 240v 50/60 Hz supply
User interface	20 x 4 Line LCD & 15 keys keyboard

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MICRO Plate 8 Channel Precision Dispensing Station

(96 Well Plate Standard) Model No: HO-BL-MPPD-214S

HOLMARC's Bio LABS™ MICRO Plate Dispensing station is a specially designed tool suitable for fast, repetitive dispensing of microliter to milliliter volumes into 8 channel well container. It ensures precise dispensing and offers an economical, compact, and reliable alternative to existing microplate dispensers.

Features

- 8 Nozzle dispensing
- Accurate dispense channels
- Low dead volume
- Fast dispenses
- Adjustable dispensing range
- Configurable for different well plates

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Multi-channel Precision Line Dispenser

Model No: HO-BL-MCPLD-214L

Holmarc's multi channel line dispensing system can be used for production as well as research in life science and bio-technology for dispensing reagent liquid in line or dot format on sheet substrate. Up to four lines can be printed at the same time with different dispensing rate for each line.

Features

- Precision line dispensing facility.
- Can dispense reagent from 1 line to multi-lines or dot simultaneously.
- Reversible pump allows easy cleaning and maintenance.
- Height adjuster for tip to control space between dispensing lines.
- Programmable parameters for adjusting dispensing volume and feeding table speed.
- Separate pumping system for each channel ensures accurate dispensing

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Desktop Dispensing Unit

Model No: HO-LSDDU-A3 | HO-LSDDU-A4

Holmarc manufactures desktop dispensers for automated dispensing of fluids to well plates/ test tube arrays. Our standard model HO-LS-DDU-A3 is a three axes system which has a dispensing area of 300 mm x 300 mm. The system operates through a personal computer. Various dispensing attributes are programmable through the computer.

Features

- Operating range: X & Y axes: 300 mm, Z axis: 100 mm.
- Dispense area - 300 x 320mm.
- Repeatability: 20 microns.
- Resolution: 20 microns.
- Drive system: Stepper motors.
- Computer interface: Rs 232 C.

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SILAR COATING SYSTEM I SILAR COATING SYSTEM WITH STIRRER I SILAR COATING SYSTEM WITH MAGNETIC STIRRER
SILAR COATING SYSTEM WITH MAGNETIC STIRRER & ULTRASONIC BATH STAND I SPRAY PYROLYSIS EQUIPMENT I SPRAY PYROLYSIS EQUIPMENT TABLE TOP MODEL
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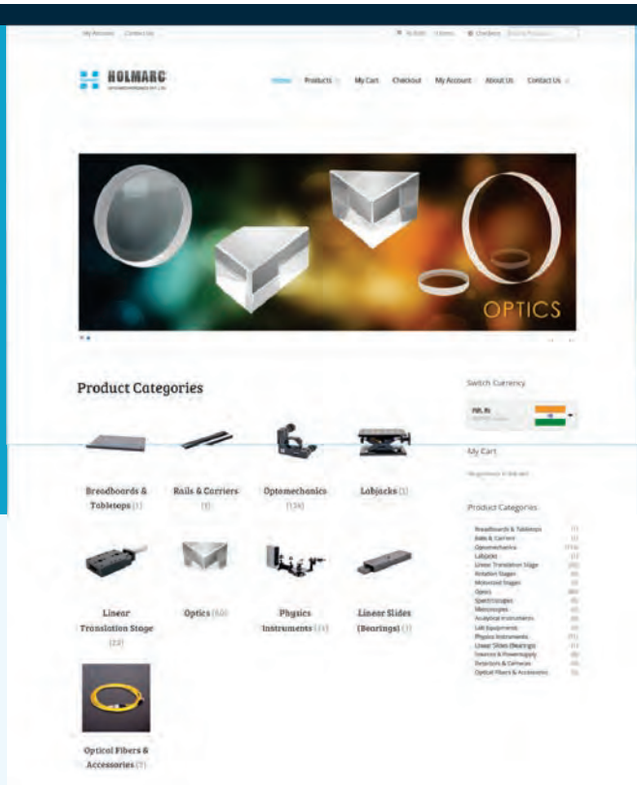
SYRINGE PUMP / INFUSION PUMP I PROB STATION I SINGLE CHANNEL DISPENSING STATION I MICRO PLATE 8 CHANNEL PRECISION DISPENSING STATION
MULTI CHANNEL PRECISION LINE DISPENSER I DESKTOP DISPENSING UNIT



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