HOLOGRAPHY

Equipments for Education, Research & Industry

INTRODUCTION

Welcome to our 2020 - 2021 edition of Product Catalog. We would like to thank you for your continue support and encouragement. Throughout this challenging time, we have grown and transform our business to be more efficient and effective. This will enable us to offer better service and more competitive pricing to our customers.

Our new edition of catalog comes with a easy reference features where we categorized the products into different usage categories, i.e. Advanced Material, Renewable Energy, Bio-Process, Gauge Calibration, Membrane Technology, 3D scanner and others. This will facilitate the users to quickly access to the equipment specification required, and options available to them in term of measuring range or equipment complexity.

In our new catalog, we have also added the equipment to do research in renewable energy like solar cell, fuel cell, flow cell, lithium ion batteries, and membrane technologies. In synergy with our advanced material equipment, we have also added the equipment for material characterization especially in the area of rare earth research and magnetic properties. In line with the manufacturing industry footsteps, the equipment on 3D scanning and 3D printing also have been added in to expand the tools in the research and development for industry 4.0.

To our current customers, we believed our partnership will be strengthen for the years to come. The new catalog will also create new opportunities to build new relationship with new customers.

Lastly, I would like to thanks our staffs for their dedication and sacrifice in supporting the management for a brighter future.

Patrick Tan
Director
KGC (Group of Companies)

Contents

LASERS & OPTO-ELECTRONICS

DIFFRACTION

OPTICS

MECHANICS

ELECTRICITY & MAGNETISM

ACOUSTICS

HOLOGRAPHY

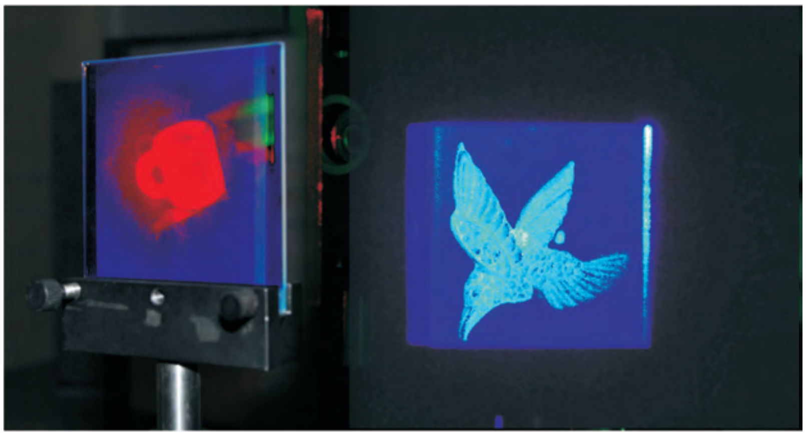
THIN FILM CHARACTERIZATION

SOLAR CELL

ASTROPHYSICS

HOLOGRAPHIC MASTER ORIGINATION SYSTEMS

1. Hologram Classic Mastering System (Model No: HO-H-CM)

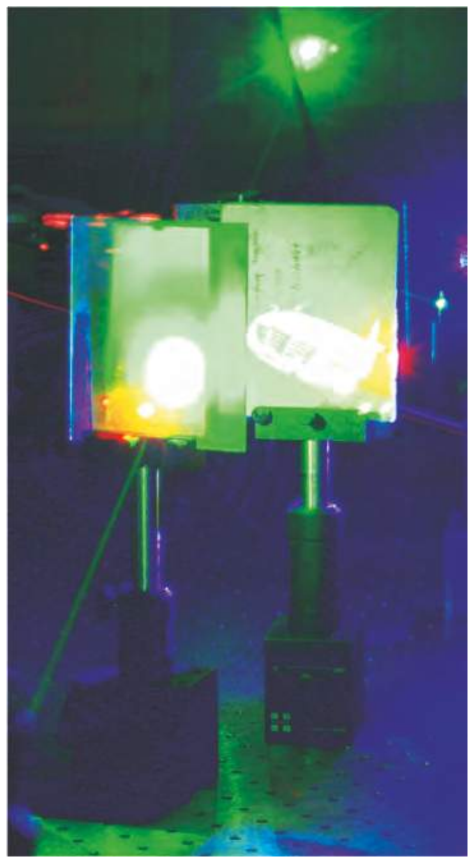


Holmarc's Classic Mastering systems are designed to deliver repeated performance in recording high quality security holograms. Our Classic mastering system includes honeycomb vibration isolation tabletop with pneumatic legs, He-Cd laser, opto-mechanics, optics, recording plate and developing chemicals. With our mastering system, one can produce classical full 3D and high security holographic images.

Types of holograms

- 2D / 3D
- Full 3D = H1-H2
  (Full aperture hologram,
  Rainbow Hologram)
- Flip-Flops
- Micro texts
- Hidden Images
- Kinetic Effects
- Diffraction gratings

Component Lists
He-Cd laser, linearly polarized, 441.6nm (100mW)
He-Cd laser mount with table and rigid support
Honeycomb Table Top - 8'x4' (M6 Tapped holes @ 25 x 25mm array)
Pneumatic Isolated support for the above honeycomb table
Beam steering device with magnetic base
2" Kinematic Mirror Mount with post, post holder and magnetic base
2" Metallic Mirror (R ≥ 90% @ 441.6nm)
1" Kinematic Mirror Mount with post, post holder and magnetic base
1" Metallic Mirror (R ≥ 90% @ 441.6nm)
Spatial Filter Assembly with post, post holder and magnetic base
Microscope Objective (40X, 0.65 NA)
Microscope Objective (20X, 0.40 NA)
Microscope Objective (10X, 0.25 NA)
Pinhole (10 microns)
Pinhole (15 microns)
Pinhole (25 microns)
Variable Beam splitter Mount with post, post holder and magnetic base
Variable Beam splitter (Dia = 100mm, Thick = 3mm, R = 10-95%@441.6nm)
Kinematic 50/50 beam splitter mount with post, post holder and magnetic base
50 / 50 metallic beam splitter
Holographic Plate Holder with post, post holder and magnetic base
Object/film holder with post, post holder and magnetic base
Cylindrical Lens Mount with post, post holder and magnetic base
Cylindrical Lens
Collimating Lens mount with post, post holder and Magnetic base
Collimating Lens
Baffle Screen
Slit
Mechanical shutter(computer controlled)
VRP-M Plates (size = 2.5"x2.5")
VRP-M plate developing chemicals
Photoresist plate samples
Photoresist developing Chemicals
Silvering Chemicals



VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882

2. Hologram Recombination Machine (4 tons) (Model : HO-H-MR4)

Hologram recombination machines are used to transfer the image from the Nickel shim (master) to a special plastic namely polycarbonate sheet. The transfer quality on the plastic depends on temperature, pressure and machine used. A bigger master can be made from smaller master using this machine.

This is a compact recombination machine with maximum hologram master size 30 mm x 30 mm. We have provided motorized travel in X & Y directions for the polycarbonate sheet holder. Maximum travel is upto 400 x 400 mm.

The unique design of the press ensures no movement of the shim during continuous operations. The equipment can be controlled by PC using a user friendly software and also by an inbuilt Front Panel Controller. The shim can be heated upto 150 Degree Celsius before stamping. N2 nozzle is incorporated with the machine to clean the recombination plates / area.

Specifications :

Recombining Area	: 400mm x 400mm
Plastic Sheet Area	: 430mm x 430mm
Maximum Image Size	: 30mm x 30mm
Working Pressure(Hydro-pneumatic Cylinder): 4 tons	
X - Y Stage travel	: 400mm x 400mm
Controller	: PC and Manual- Front Panel Controller
Resolution	: 10 microns
Heater	: Electrical heater controlled by micro controller based temperature controller with digital display.
Maximum Temperature	: 150°C
Construction	: Solid Steel construction

3. Hologram Recombination Machine (30 tons) (Model : HO-HRM-30)

Hologram recombination machines are used to transfer the image from the Nickel shim (master) to a special plastic namely polycarbonate sheet. The transfer quality on the plastic depends on temperature, pressure and machine used. A bigger master can be made from smaller master using this machine.

This recombination machine can be used with narrow and wide web and with dot-matrix masters. The maximum hologram master size is 50 mm x 50 mm. The maximum tonnage is upto 30 Tons.

We have provided motorized travel in X & Y directions for the polycarbonate sheet holder. Maximum travel is upto 1 meter x 1 meter. The unique design of the press ensures no movement of the shim during continuous operations.

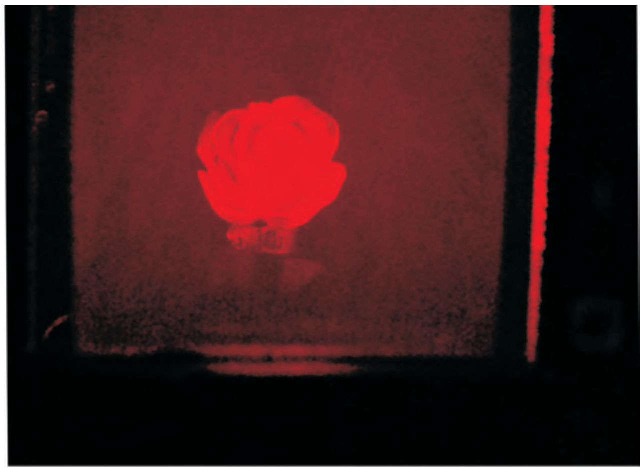
The equipment can be controlled by PC using a user friendly software and also by an inbuilt Front Panel Controller. The shim can be heated upto 150 Degree Celsius before stamping. N2 nozzle is incorporated with the machine to clean the recombination plates / area.

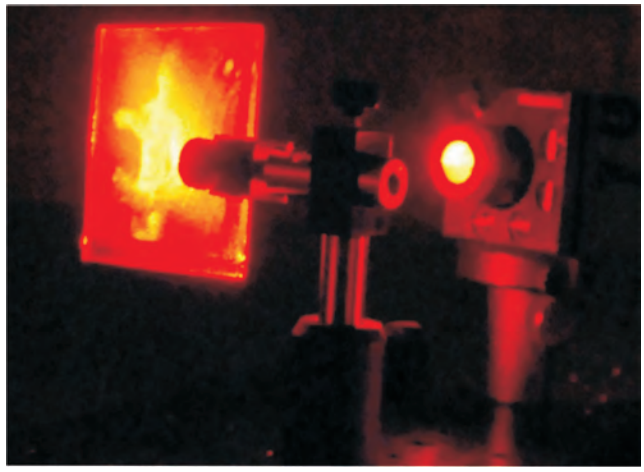
Specifications :

Recombining Area	: 1000mm x 1000mm
Plastic Sheet Area	: 1100mm x 1100mm
Maximum Image Size	: 50mm x 50mm
Working Pressure(Hydro-pneumatic Cylinder): 30 tons	
X - Y Stage travel	: 400mm x 400mm
Controller	: PC and Manual- Front Panel Controller
Resolution	: 10 microns
Heater	: Electrical heater controlled by micro controller based temperature controller with digital display.
Maximum Temperature	: 150°C
Construction	: Solid Steel construction

HOLOGRAPHIC EDUCATIONAL KITS

1. Hologram Demo Sytem (Model No: HO-H-01)





Fringe pattern in the hologram appears meaningless to the naked eye. However, it has the property of recreating the object beam's wavefront when it is illuminated with a beam of light coming from the same direction as the original reference beam. When a viewer looks at the illuminated hologram, sees the wavefront and interprets it as light coming from the original object. Unlike in the case of a photograph, the three dimensionality of the original object is preserved by the hologram.

A 5mW RED diode laser is used in this setup, which is the most common colour used for creating holograms. The laser beam is set at expanded mode, so that we can achieve full illumination in the plate and students can clearly see a 3-D image of hologram.

The objective of this apparatus is to demonstrate transmission holograms in class room and laboratary.

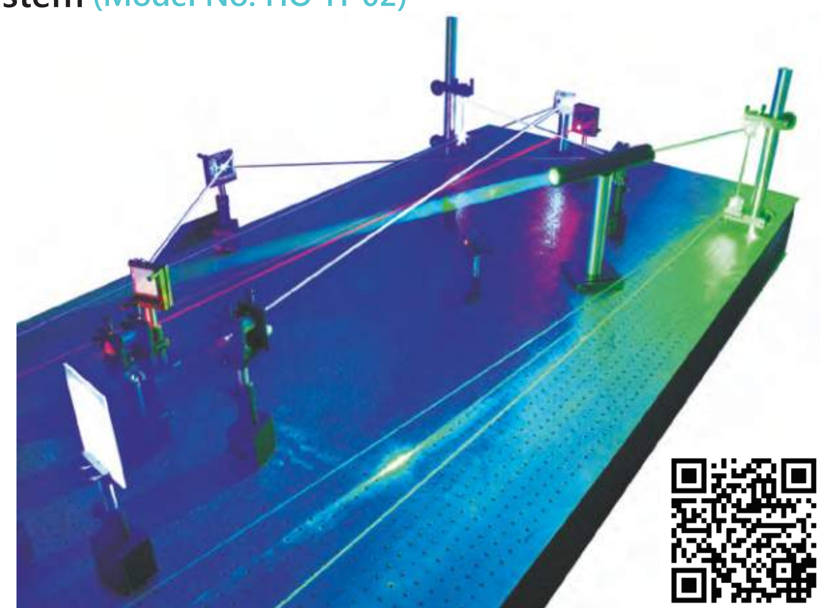
Laser module consists of an encased index guided AlGaInP laser diode with 5mW power output at 650nm wave length.

We provide tilt adjustments and angular movements in the plate holder so that transmission holograms created in any angle works easily with the system.

2. Holography Educational system (Model No: HO-H-02)

Holmarc's holographic kit is a professional set up for shooting holograms in academic and research institutions. The equipment includes vibration isolated table, optomechanical modules, optical components, sample silver halide plate, processing chemicals etc. All components and modules used in the kit are of industrial quality and reliability. By changing the laser source and recording plates, the equipment can be used for shooting commercial hologram as well. Thorough training in hologram making is given to all our customers free of cost at our holographic laboratory with either He-Cd or He-Ne lasers.

Our Instruction manual contains experimental setups, principles, procedures, step-by-step instructions and required photographs to perform the experiment.



Experimental arrangement for transmission hologram - *Holmarc Holography Lab inc.*

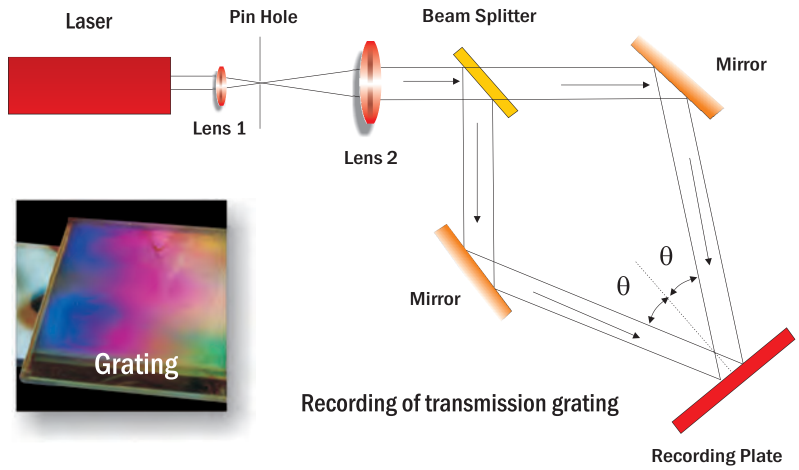
He-Ne laser :He-Ne lasers provide superior optical characteristics. He-Ne output is well-collimated and does not require external optics. He-Ne lasers also offer excellent coherence lengths (10cm to several meters).

VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882

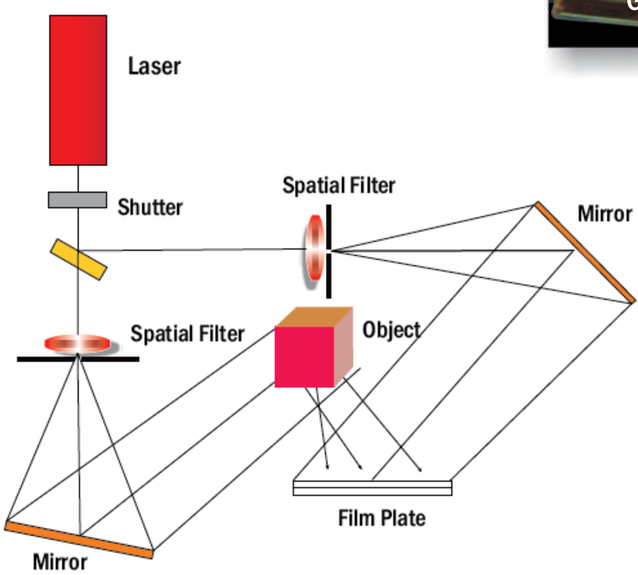
With Model No: HO-H-02 customer can perform following three experiments :

1. Creation of Transmission Grating

The experiment involves the creation of transmission grating using holography on a sliver halide plate. The grating pitch is governed by the angle between the two incident beams that hit on the plate. We provide all the optics, opto-mechanics, laser, holographic plate and developing chemicals to perform the experiment.



Recording of transmission grating

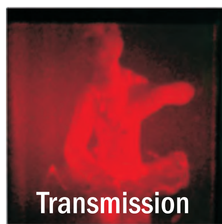


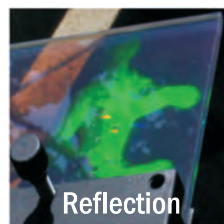
Recording transmission hologram

2. Recording and Reconstruction of Transmission Holograms

To create a transmission hologram, split the laser beam into two. The beam reflected from the object is called object beam and the other one, a plane wave without any information, is called the reference beam. The exposure time varies from seconds to minutes depending on the object. Absolutely stable conditions are required during the exposure of the film. Variable beam splitters are provided to finely adjust the beam ratio.

To reconstruct the image, the plate is developed in the developer solution and is placed in its original position compared to the reference beam during its recording.

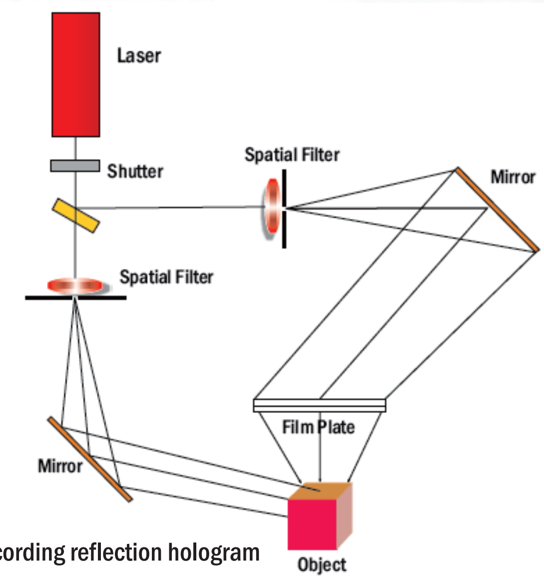




3. Recording and Reconstruction of Reflection Holograms

Setup for the creation of reflection hologram is the same as transmission hologram except the reference beam is lit from behind the plate. Controlling the beam ratio is very important in creating reflection holograms. We use variable beam splitter for the purpose.

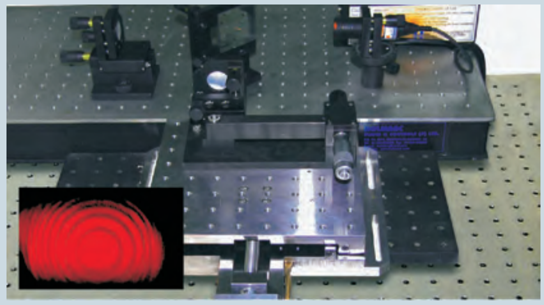
In the case of reflection hologram, a truly three-dimensional image can be seen near its surface. The hologram is illuminated by a "spot" of white incandescent light, held at a specific angle and distance, located on the viewer's side of the hologram.



Recording reflection hologram

Interferometric test setups using michelson interferometer

The Michelson interferometer is the most common configuration for optical interferometry. The Michelson interferometer produces interference fringes by splitting a beam of monochromatic light so that one beam strikes a fixed mirror and the other, a movable mirror. When the reflected beams are brought back together, it results in an interference pattern.



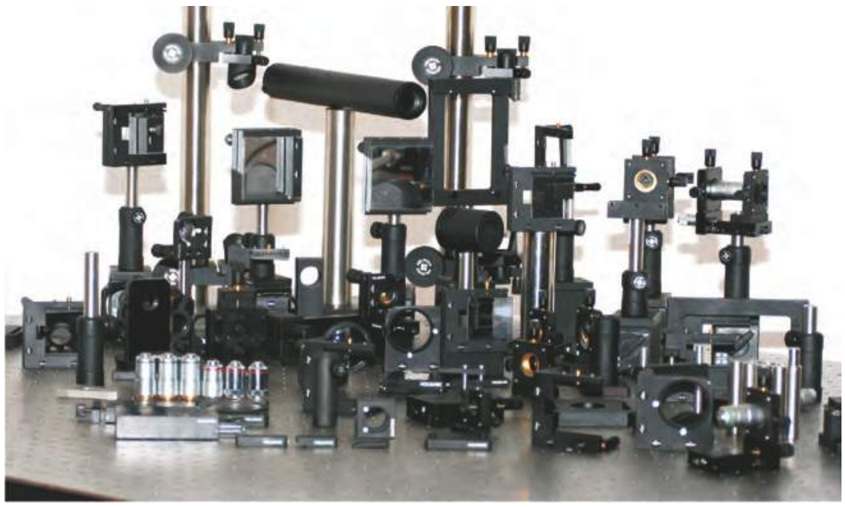
Precise distance measurements can be made with the Michelson interferometer by moving the mirror and counting the interference fringes that move by a reference point. The distance 'd' associated with 'm' fringes is

d=m(lambda)/2

This interferometer is very sensitive to linear displacement and can measure it accurately. We provide total assistance for building interferometric setups.

Components Included in Holographic Educational system

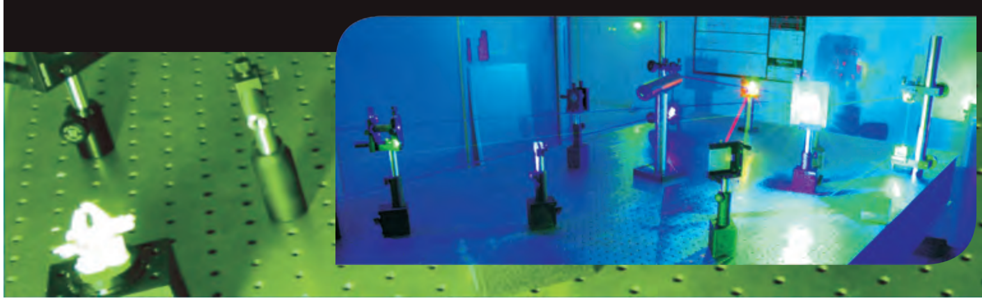
- Optical honeycomb tabletop
- Pneumatic isolated support
- He-Ne laser
- Laser clamp
- Beam steering device
- Mirror mount
- 2" Mirror mount
- Variable beam splitter mount
- Spatial filter assembly with magnetic base
- Screen
- Object holder
- Sample objects
- Pinhole and microscope objective
- Plate Holder
- 25mm dia mirror
- 50mm mirror
- Variable beamspliter
- Holography plate
- Developer chemical
- Plastic tray



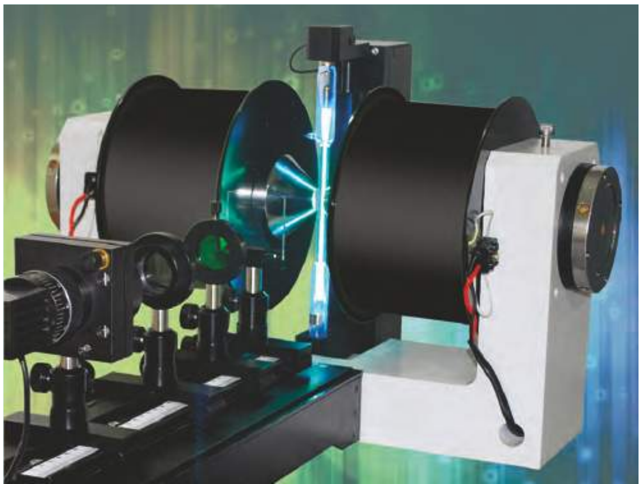
Training Program for Holography

HOLMARC

We Conduct regular training programs for the production of Hologram masters.



HOLMARC OPTO-MECHATRONICS PVT LTD
OFFICE & FACTORY ADDRESS
B.7, H.M.T. INDUSTRIAL ESTATE,
H.M.T. P.O, KALAMASSERY,
KOCHI, KERALA,INDIA
Ph.No. 91-484 2540075
Website: www.holmarc.com
E-mail:sales@holmarc.com



1. SPECTROSCOPY

(1) Spectrometer-Goniometer
Model : HO-ED-S-01

Spectrometer-Goniometer 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

(2) CCD Based Constant Deviation Spectrometer
(For Arc Emission & Absorption Measurements)
Model : 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.

Experiment Examples:
· To measure the wavelength of absorption bands of KMnO4 and calculate it's Hartmann's constant.
· To find wavelength of prominent lines of the emission spectra of copper, iron and brass.

(3) Flame Spectrometer
Model : 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 is able to analyze the spectrum of samples repeatedly with high speed.

Experiment Examples:
· Calibration of prism spectrometer using Hartmann constants
· Absorption spectrum of sodium D lines
· Emission spectrum of sodium metal /customized materials

(4) Hydrogen Spectra - Balmer Series
(Determination of Rydberg's Constant)
Model : 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. Furthermore, these atoms can absorb light having the same wavelength as the wavelength of the emitted ones. The emission spectrum of atomic hydrogen is divided into a number of spectral series, with wavelengths given by the Rydberg's formula. 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.

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

(5) Zeeman Effect Apparatus
Model : HO-ED-S-04A

Holmarc's Zeeman Effect Apparatus 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 its 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: Observing the line triplet for the normal transverse Zeeman Effect.
· To perform quantitative measurements on the normal Zeeman effect including:
  To find Spacing of the etalon
  Verification of the magnetic moment constant Bohr magneton(μ)
  Analysis of Planck's constant (h) and speed of light(c) using Zeeman Effect
  Calibration of the magnetic field

(6) Laser Raman Spectrometer (PMT Based)
Model : HO-ED-S-06

Laser Raman Spectrometer (Model : 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. Sample can be either liquid or solid.

Experiment Examples:
· To record the vibrational Raman spectrum of CCl4 molecule.
· To record the polarized Raman spectrum of CCl4 molecule.
· To calculate the depolarization ratio of CCl4 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, Isopropanol etc or unknown chemicals

(7) Laser Raman Spectrometer (CCD Based)
Model : HO-ED-S-06A

Holmarc's CCD Based Laser Raman Spectrometer apparatus 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.

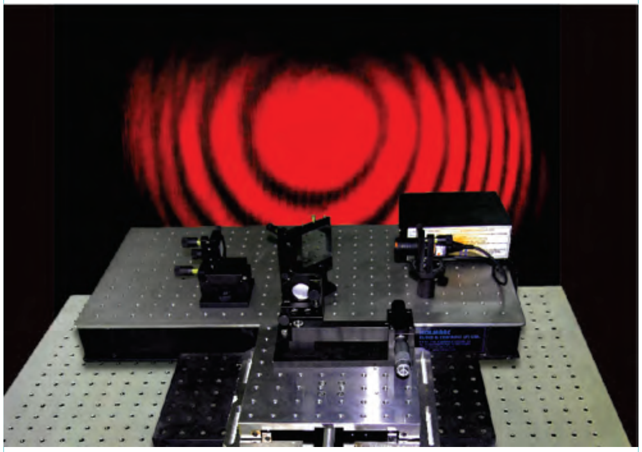
VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882

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, Isopropanol etc or unknown chemicals.

(8) Confocal Laser Raman Spectrometer
Model : 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.



2. INTERFEROMETRY

(1) Newton's Rings Apparatus
Model : 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.

(2) Cornu's Interference Apparatus
Model : 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

(3) Michelson Interferometer (Standard Model)
Model : HO-ED-INT-06

Michelson interferometer is a widely used instrument for measuring wavelength of light, refractive index of transparent materials etc.

The interferometer 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 M1, the other is transmitted towards mirror M2. Half the light is transmitted through the beam splitter to M1 and the other half is reflected by beam splitter to M2. The reflected beams from M1 and M2 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.

(4) Michelson Interferometer (Compact Model)
Model : 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 M1, the other is transmitted towards mirror M2 .Half the light is transmitted through the beam splitter to M1 and the other half is reflected by beam splitter to M2. The reflected beams from M1 and M2 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

(5) Magnetostriction with Michelson Interferometer
Model : 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.

Experiment Examples:
· To study magnetostrictive properties of various materials (iron, nickel, and copper).

(6) Michelson Interferometer (Sodium D' Lines)
Model : 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 D1 and D2Fraunhofer 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 D1&D2lines of sodium light
· To determine the wavelength of monochromatic light
· To measure refractive index of transparent materials

(7) Michelson Interferometer (Piezo Electric Effect)
Model : 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). A piezoelectric actuator converts an electrical signal into a precisely controlled physical displacement (stroke). 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.

Experiment Examples:
· To observe the Piezo Electric Effect.
· To obtain the displacement factor by counting the fringe shift.

(8) Mach Zehnder Interferometer
Model : HO-ED-INT-12

The flexibility in fringe localization is one of the important advantages of the machzehnder 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.

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.

(9) Fabry-Perot Etalon
Model : HO-ED-INT-09

Holmarc's Fabry-Perot etalon is made of plate beam splitters separated by 3mm distance. The beam splitters 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. 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.

Experiment Examples:
· To find the Spacing of the Etalon
· To find the Finesse and Free Spectral Range of the Etalon

(10) Fabry-Perot Interferometer (Projection Based)
Model : HO-ED-INT-10

In Fabry - Perotinterferometer, 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 beam splitters.

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.

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.

(11) Fabry-Perot Interferometer (CCDBased)
Model : 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 monitory using the software module provided.

Experiment Examples:
· To find the wavelength of monochromatic light
· To determine the spacing between the plates of fabryperot etalon from the fringe Pattern .
· To find the finesse and free spectral range (FSR) of etalon from the fringe calibration at different cavity thickness.

(12) Fizeau Interferometer
Model : 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.

Experiment Examples:
· To measure the optical flatness of different surfaces

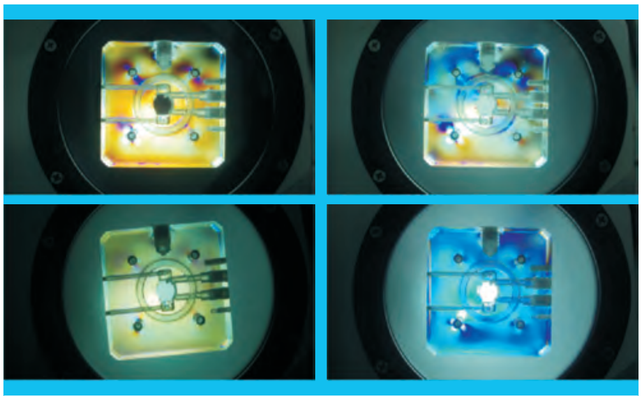
(13) Electronic Speckle Pattern Interferometer 22
Model : HO-ED-INT-15

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 analyzed using an image analysis software. Deformation causes variations in the fringe pattern. These variations can be analyzed with the help of the software provided to find the deformations.

Our ESPI system allows the user to perform the Electronic SpeckleShearographic 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.

Experiment Examples:
· To measure the displacement produced due to mechanical load and deformation due to temperature variations.

VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882



3. POLARIZATION

(1) Brewster's Angle Apparatus
Model : 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. 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.

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.

(2) Malus Law Apparatus
Model : 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.

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 its 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.

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

(3) Faraday Effect Apparatus- Laser Based
Model : 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, 532nm, 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.

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.

Experiment Examples:
· Determination of the Verdet constant of the material for a given wavelength oflight (Magneto Optic Effect)

(4) Faraday Effect Apparatus- Liquid Sample
Model : 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. 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.

Experiment Examples:
· 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.

(5) Faraday Effect Apparatus - Multi wavelength
Model : 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.

(6) Kerr Effect Apparatus
Model : 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 C6 H5NO2). 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(Nitro Benzene C6 H5 NO2).
· Determination of half-wave voltage of the cell

(7) Pockel Effect Apparatus
Model : 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.

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

(8) Apparatus for the Study of Polarization by Waveplates
Model : HO-ED-P-07

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

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.

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.

(9) Babinet Compensator
Model : 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. 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.

Experiment Examples:
· To calibrate the Babinet compensator with monochromatic light.
· Measurement of the sample birefringence.

4.FIBER OPTICS

(1) Optical Fiber Characterization Apparatus (Rail Based)
Model : 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.

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.

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.

VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882

(2) Optical Fiber Characterization Apparatus (Breadboard Based) Model : 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 ofoptical 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.

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

5. LASERS & OPTO-ELECTRONICS

(1) Apparatus for Characteristic Study of Diode Laser Model : 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.

(2) Apparatus for Laser Beam Profile Analysis Model : 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 1100nm. 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.

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.

(3) Apparatus for Opto-Electronics Characterization Model : HO-ED-LOE-02

Holmarc's Apparatus Model HO -ED -LOE-02 is for the characterization of Optoelectronic components. Optoelectronics 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.
Opto-electronics is based on the quantum mechanical effects of light on electronic materials, especially semiconductors, sometimes in the presence of electric fields.

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

(4)Z-Scan System Model : HO-ED-LOE-03

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

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

271 LABORATORY EQUIPMENTS
321 SPECTROSCOPY
361 IMAGING DEVICES
393 HOLOGRAPHY
399 PHYSICS LABS INSTRUMENTS
416 INDEX
431 CUSTOM PRODUCTS

optical effects can be measured by translating a sample in and out of the focal region of an incident laser beam.

Experiment Examples:
· To measure intensity dependent nonlinear susceptibilities of materials

(5) Apparatus for Opto-Electronics Spectroscopic Characterization (Spectral Characterization of LED)
Model: HO- ED-LOE- 04

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 nanometers. 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

(6) Determination of Conversion Efficiency of Crystals – Second Harmonic Generation
Model : HO-ED-LOE-05

The objective of this experiment is to observe non-linear effect, second harmonic generation in 2nd order nonlinear 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.

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.

Experiment Examples:
· 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.

(7) Laser Optics Lab
Model : 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.

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.

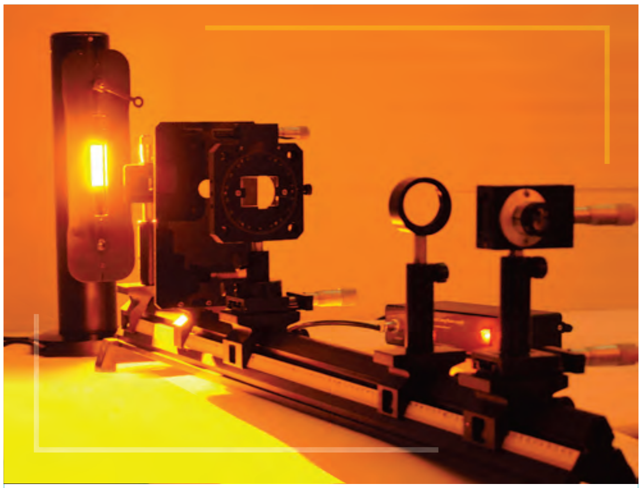
POLARIZATION
· Polarization of light and verification of Malus law.
· Determination of refractive index of transparent material by finding Brewster's angle.

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.

Visit us @ http://www.holmarc.com/physics_lab_instruments.php

VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882



6. DIFFRACTION

(1) Screen Based Apparatus for Diffraction Experiments
Model : 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.

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)

(2) Detector Based Apparatus for Diffraction Experiments
Model : 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.

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.

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)

(3) Single Slit Diffraction and Heisenberg's Uncertainty Principle
Model: HO-ED-D-02A

Holmarc's Apparatus Model is meant for the study of diffraction patterns of single slits and to confirm Heisenberg's uncertainty principle. Here, the diffraction pattern is closely studied using a detector mounted on a translation stage. The device consists of one meter long optical rail along with carriages 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 measurements easy and convenient.

In this apparatus, diffraction experiments using single slits are carried out with a photo sensitive detector and diode laser is used as light source. The diffraction slit 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. The results are evaluated both from the diffraction pattern viewpoint, and from the quantum mechanics stand- point to confirm Heisenberg's uncertainty principle. Thus this apparatus clearly reveals that the narrow slit produces a broader momentum distribution. This confirms the Heisenberg's uncertainty principle in a single slit diffraction.

Experiment Examples:
· To observe the diffraction pattern and calculate the slit width.
· To calculate the uncertainty of momentum from the diffraction patterns of single slits of differing widths and to confirm Heisenberg's uncertainty principle.

(4) Goniometer Based Apparatus for Diffraction Experiments
Model : 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.

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.

Experiment Examples:
· Diffraction of light by single slit Transmission grating
· 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

(5) Apparatus for Studying Diffraction from Reflection Grating
Model : 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

(6) Apparatus for Determination of Particle Size
Model : 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.

Experiment Examples:
· To determine particle size of lycopodium using laser beam diffraction

(7) Fresnel's Biprism Diffraction Apparatus
Model : 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 source due to the creation of two virtual coherent sources as the single 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.

Experiment Examples:
· To find the wavelength of the sodium light using bi-prism diffraction experiment

7. OPTICS

(1) Liquid Lens Apparatus
Model : HO-ED-O-01

Holmarc's Liquid Lens Apparatus (Model : 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.

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.

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.

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

(2) Geometrical Optics Experiment Apparatus
Model : HO-ED-O-02

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. 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.

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

(3) Refractometer-Basic model
Model : 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.

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.

Experiment Examples:
· Refractometer calibration
· To find the refractive index of an unknown solution

8. MECHANICS

(1) Contact Angle Meter
Model : HO-ED-M-01

Holmarc's (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.

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.

Experiment Examples:
· To measure the contact angle of liquids over various solids.

(2) Young's Modulus Apparatus
Model : 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 Examples:
· To find the Young's modulus of the material of a bar by uniform and non uniform bending using
a. Pin and microscope method
b. Optic Lever Method

(3) Lee's Disc Apparatus
Model : 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.

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

9. ELECTRICITY & MAGNETISM

(1) Millikan's Oil drop Apparatus
Model : HO-ED-EM-01

Holmarc's Millikan oil drop apparatus (Model : 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. 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.

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.

Experiment Examples:
· To determine the charge of an electron by Millikan's Oil Drop Method

(2) Apparatus for the Study of Photo Electric Effect (Planck's constant)
Model : HO-ED-EM-02

Holmarc's Photo Electric Apparatus (Model : 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.

Experiment Examples:
· Determination of Planck's constant
· Determination of work function of the material

(3) e/m Experiment Apparatus – Thomson's Method
Model : 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 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.

Experiment Examples:
· To measure the Charge to Mass ratio of Electron (e/m)

(4) Franck-Hertz Experiment Apparatus
Model : 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.

(5) Apparatus for the Study of Biot- Savart's Law
Model : 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 find the number of turns of a single coil using the measurement of its axial field at various distances from the center of the coil.
· To find the radius of a coil using the measurement of its field at the center of the coil.
· Magnetic field measurement of Helmholtz coil and plotting the graph.

(6) Hall Effect Apparatus
Model : 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. Electromagnets, 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.

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.

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

(7) Magnetic Susceptibility – Quincke's Method
Model : 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.

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.

Experiment Examples:
· Calibration of the magnetic field
· Measurement of magnetic susceptibility of paramagnetic Solutions

(8) Magnetic Susceptibility – Gouy's Method
Model : HO-ED-EM-08

Holmarc's Magnetic Susceptibility - Gouy's Method Apparatus (Model : 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.

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.

Experiment Examples:
· Calibration of the magnetic field
· Measurement of Magnetic Susceptibility of paramagnetic solid samples

10. ACOUSTICS

(1) Detector Based Apparatus for Ultrasonic Diffraction
Model : 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. 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.

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.

(2) Screen Based Apparatus for Ultrasonic Diffraction
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.

The ultrasonic waves generated by the transducer travels down the medium (liquid) and get 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.

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.

(3) Kundt's Tube Apparatus
Model : 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 antinodes at open ends. Furthermore, it provides an insight into the interesting phenomenon of standing sound waves.

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.

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

(4) Impedance Tube Apparatus
Model : 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 modulus) of acoustic materials in normal incidence conditions.

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.

Experiment Examples:
· Measurement of acoustical properties of materials
· Measurement of absorption and reflection coefficient of materials
· Measurement of transmission loss

11. HOLOGRAPHY

(1) Holographic Lab
Model : 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.

Experiment Examples:
· Recording of Diffraction Gratings.
· Recording and reconstruction of Transmission Holograms.
· Recording and reconstruction of Reflection Holograms.

VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882

12. THIN FILM CHARACTERIZATION

(1) Spectrophotometer
Model : 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.

Experiment Examples:
· To study the absorbance and transmittance of different samples at different wavelengths
· To plot the graph of absorbance Vs. wave length

(2) Variable Angle Laser Ellipsometer
Model : 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 provides unequaled capabilities for thin film metrology. As an optical technique, ellipsometry is non destructive and contact less. The optical thickness or refractive index 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.

Experiment Examples:
· Study of refractive index of thin films
· Thickness of thin film samples

(3) Spectroscopic Ellipsometer
Model : 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.

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.

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)

Experiment Examples:
· Study of refractive index of thin films
· Analyze single or multi-layer films
· Measurements of thickness and optical constants of thin film samples

(4) Thin film Spectroscopic Reflectometer
Model : 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.

Features:
· 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
· Parameterized models

Experiment Examples:
· Study of refractive index of thin films
· Analyze single or multi-layer films
· Measurements of thickness and optical constants of thin film samples
· FFT based thickness measurement

(5) Theta- 2Theta Advanced Spectrophotometer
Model : 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 tools 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.

This advanced spectrophotometer gives precise measurements of spectral parameters such as reflection, transmission, and optical

271 LABORATORY EQUIPMENTS
321 SPECTROSCOPY
361 IMAGING DEVICES
393 HOLOGRAPHY
399 PHYSICS LABS INSTRUMENTS
431 CUSTOM PRODUCTS
416 INDEX

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° can be carried out with this spectrophotometer. Two research 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.

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

SOLAR CELL

(1) Solar Cell Characterization Apparatus (I-V Characteristics)
Model : HO-ED-SC-01

Apparatus for Characteristic Study of Solar Cell (Model No: HO-ED-SC-01) is an effective tool for evaluating t h e 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.

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

(2) Spectral Response Measurement Apparatus
Model No: HO-ED-SC-02

HOLMARC's Spectral response measurement system (Model : 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 2 sensors in an area up to 30mm .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 Examples:
· To measure spectral response of a solar cell

(3) Quantum Efficiency Measurement Apparatus
Model : 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

(4) Thermally Stimulated Current (TSC) Spectrometer
Model : 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° C. The sample can then be heated gradually up to 150 °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.

Experiment Examples:
·To study energy levels in semiconductors or insulators, especially solar cells

(5) Conductivity Cell Measurement Apparatus
Model : 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° 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.

Experiment Examples:
· To measure the conductivity of semiconducting thin film samples.

VISIT US @ www.holmarc.com
E-mail: sales@holmarc.com | mail@holmarc.com
Ph: 91-484-2540075
Fax: 91-484-2540882

13. ASTROPHYSICS

(1) Solar Characteristics Measurement Set up
Model : 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.

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

(2) Astronomy & Astrophysics Experiment Set up
Model : HO-ED-AP-04

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 700nm 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.

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.

KGC

EMPOWERING FUTURE
THROUGH RESEARCH & INNOVATION

DESIGN YOUR PERFECT LABORATORY WITH OUR

PRODUCT CATALOG

For South East Asia Inquiries:

KGC RESOURCES SDN BHD (223165-D)
No. 2-2-3, Jalan Setia Prima E
U13/E Setia Alam, Seksyen U13
40170, Shah Alam, Selangor
Malaysia

WhatsApp Us at: **+6014 964 9880**
Call Us at: **+603 3341 2880**
Search Us at: **www.kgcscientific.com**
Email Us at: **sales@kgcscientific.com**
or **info.kgc00@gmail.com**

For Indonesia Inquiries:

PT KGC SAINTIFIK
Jalan Kamal Raya (Kompleks Ruko CBD)
Blok A2-07, Cengkareng Timur
Jakarta Barat 11730
Indonesia

WhatsApp Us at: **+62 899 7255 675**
Call Us at: **+62 212 2522 110/+62 212 2522 114**
Search Us at: **www.kgcscientific.com**
Email Us at: **sales@kgcscientific.com**
or **info.kgc09@gmail.com**