



भौतिकशास्त्र

PHYSICS

DEPARTMENT OF PHYSICS

Physics Instrumental Facility Center (PIFC)

Facilities available

- Scanning Electron Microscope (SEM) with EDS
- Field Emission Scanning Electron Microscope with EDS
- X- Ray Diffractometer (XRD)
- Atomic Force Microscope
- FT-IR Spectrometer
- Spectroscopic Ellipsometer
- LCR Meter Bridge
- Electrochemical Impedance Spectrometer (EIS)
- FT-RAMAN spectrometer
- Contact angle meter
- Surface area analyzer (BET)
- Solar Simulator
- Electrochemical Quartz Crystal Microbalance (EQCM)
- Scanning electrochemical microscope (SECM)
- IMPS/ IMVS (In situ Spectroelectrochemistry)
- Electrochemical workstation
- Spectrofluorometer (PL)
- Surface Profiler
- Uv-Vis Spectrophotometer
- Electrometer

PIFC at Glance

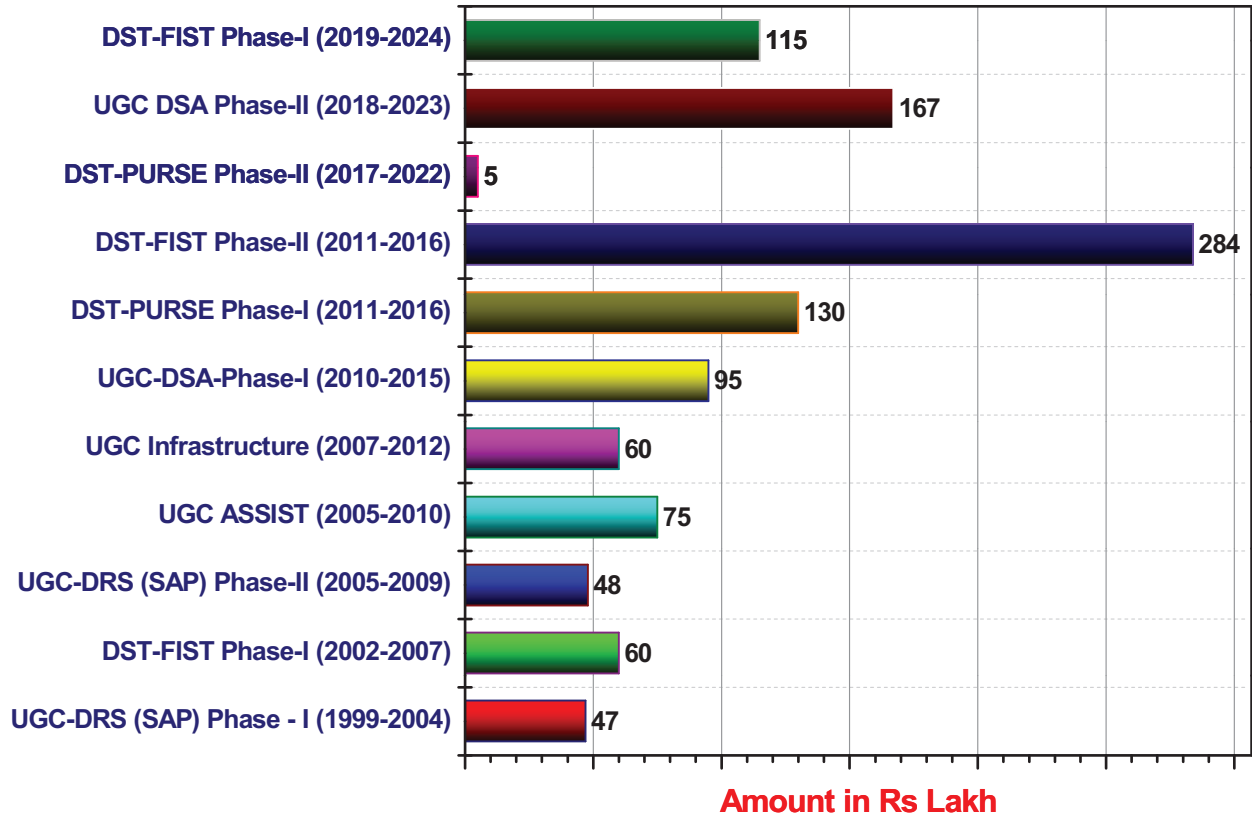
In the recent past, the year 2014 has been celebrated by us as the Golden Jubilee Year. Since the inception of the Department of Physics, it is headed by the legacy of renowned academicians like Prof. Dr. A.V. Narlikar through Prof. Dr. S. H. Pawar to Prof. Dr. C. D. Lokhande, and Prof. Dr. P.S. Patil. At present, the Departmental Academic Mission is shouldered by the youngest Head of Department Prof. Dr. K. Y. Rajpure.

The Department of Physics offers four specializations viz. Solid State Physics, Modern Optics, Space Science and Theoretical Physics under Masters Programme (M.Sc.) on the other hand M.Phil. & the Ph.D. programme is related to relevant research trends evolved through different specializations and theoretical aspects of Non-linear Optics as well. The thrust area of research in the Department of Physics is Material Science and is successfully marching towards Device Fabrication.

The emergence of research eco-system, Physics Instrumentation Facility Centre (PIFC) developed through coherent efforts of the faculties in the Department of Physics has made its unique identity rather Benchmark at National Research Sector. Through the synergy among faculties in the Physics Department and exploration of different Funding agencies such as UGC, DST, CSIR etc. clearly implies research flavour of Physics fraternity in the Department. The PIFC not only offers facilities but also act as a research motivating centre for budding researchers at school and college level. We claim, PIFC is the key centre, for one of the best practices of the Physics Department, advocating academic consultancy on the campus.

The details of funding agencies and funds are noteworthy and subsequently, it proves our accountability and dedication towards research. The whole canvas of research eco-system with few new additions is opened up now in pages ahead for all our academic and industrial clients.

Departmental Projects pertaining to these facilities



Scanning Electron Microscope (SEM) with EDS



Make: JEOL Ltd. Japan Model: JSM-6360

Brief description:

It is type of electron microscope that produces images of a sample by scanning the surface with focused electron beam. It detects back scattered electrons for the image formation after the interaction between electron beam and sample surface. The thermoionic mechanism constitute to the generation of electrons.

Specifications

System Type	Fully Integrated PC
Resolution	3 nm at 30 KV
Photo magnification	30 X to 100000 X
Operating Voltage	500 V to 30 KV

Applications:

Morphological study of thin films, Chemical analysis from Na-U, Powder, Pellets of Metals, Metal Oxides, Polymers, Alloys.

Field Emission Scanning Electron Microscope (FESEM) with EDS



Make- TESCAN, Brno, Czech Republic, EU Model- MIRA3 LMH

Brief description

- In FESEM electrons are emitted by the field emission process and sample under study is scanned by electrons according to a zig-zag pattern.
- Dry, non-magnetic and powder/metal/thin-film samples are required for FESEM analysis
- It has ability to examine smaller-area contamination spots at electron accelerating voltages compatible with energy dispersive spectroscopy.
- FESEM can give High-quality, low-voltage images with negligible electrical charging of samples

Specifications

Resolution	Upto 1.5nm
Magnification	X20 to X 800000
Probe current	12pA to 100nA
EHT	500V to 30kV

Applications:

- Thickness measurement of thin coatings and films
- Correlation of surface appearance and surface morphology
- Characterization of size, size distribution, shape.
- Measurement of height and lateral dimensions of nanometer-sized objects
- Elemental analysis of micron-sized features
- Fracture and failure analysis Metallurgy
- Defect analysis
- Elemental mapping

X- Ray Diffractometer (XRD)



Make: Bruker Ltd.Germany Model: D2 Phaser

Brief description

- X-ray diffractometer is a powerful tool for Crystallographic study in material science.
- It works on the principle of Braggs diffraction law.
$$2d \sin \theta = n\lambda$$
- The output results are obtained as a graph of intensity verses angle 2θ .

Specifications

System Type	Portable Desktop instrument with fully integrated PC
Geometry	θ - θ
Scanning Range	3° to 160°
Detector	LYNXEYE (TM)
Target	Copper (Cu) $\lambda = 1.54\text{\AA}$

Applications:

- To determine structural properties: lattice parameters, strain, crystallite size, phase composition, orientation, crystallinity of material, interplanar spacing between two planes etc.
- To distinguish amorphous or crystalline nature of materials.

Atomic Force Microscope (AFM)



Make: USA Model: INOVVA 1B3BE

Brief description

- AFM microscopes operate on the principle of surface sensing using an extremely sharp tip on a micromachined silicon probe.
- Innova Atomic Force Microscope (AFM) delivers accurate, high-resolution imaging and a wide range of functionality for advanced research in physical, life, and material sciences.
- It offers a unique, state-of-the-art closed-loop scan linearization system that ensures accurate measurements and noise levels approaching those of open-loop operation.

Specifications

Operating Mode	(1) Contact mode (2) Tapping Mode
XY Scan Range	1-90 μm
Z Scan Range	50 nm-7.5 μm

Applications:

- To determine the particle size and roughness of the sample in material science
- To capture 2D and 3D images of the surface
- In the field of stem cell and tissue engineering

FT-IR Spectrometer



Make : JASCO Japan Model : FT/IR-4700

Brief description

- FTIR uses IR light to scan test samples and observe chemical properties.
- It is a powerful tool for identifying types of chemical bonds in a molecule by producing an IR absorption spectrum.
- This spectrometer measures IR induced stronger molecular vibrations in covalent bonds, which can be viewed as springs holding together two masses, or atoms.
- Fourier analysis builds relationship between a signal in time domain and its representation in frequency domain.

Specifications

Wavenumber Range	7,800 to 350 cm^{-1}
Resolution	Upto 0.4cm
Optical system	Single beam
Raid scan	10Hz

Applications:

- Identification of organic, polymeric, and inorganic materials.
- Determination of chemical, physical and rheological properties and grain hardness
- Determination of extra virgin olive oil adulteration with various vegetable oil

Spectroscopic Ellipsometer



Make: J.A. WOOLLAM CO., INC. USA Model: alpha-SE

Brief description

- Ellipsometer measures a change in polarization as light reflects or transmits from a material structure. The polarization change is represented as an amplitude ratio, Ψ , and the phase difference, Δ .
- Spectroscopic ellipsometer alpha-SE contain visible source and scan the sample on various angles (65° , 70° , 75°). This instrument has provision of measurement in transmission mode (90°).
- The physical parameters like thickness and roughness of the sample is determined by simulating the experimental data using various mathematical models.

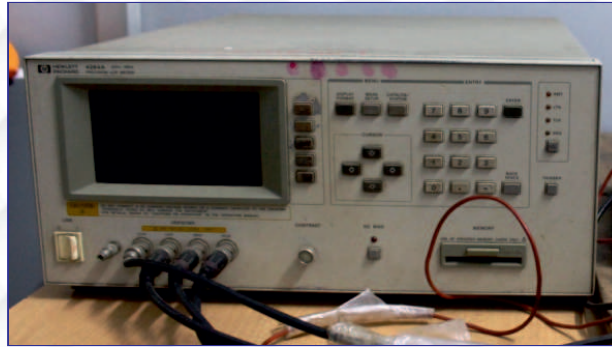
Specifications

Wavelength Range	380-900 nm
Detector	CCD
Angles of Incidence	65° , 70° , 75° or 90°
Data Acquisition Rate	3 sec. – Fast mode 10 sec. – Standard mode 30 sec. – High-precision mode

Applications:

- Measurement of optical constants: Refractive index (n), Extinction coefficient (k) and Complex dielectric function (ϵ).
- Measurement of film thickness and roughness of thin films.

LCR Meter Bridge



Make: Hewlett Packard (HP) Model: 4284A

Brief description

- It is basically inductance L, capacitance C, and resistance R measuring device.
- LCR Meters are generally used for easy and accurate evaluation of components like capacitors, inductors, transformers and electromechanical devices.
- LCR Meter for electrical properties measurement with respect to frequencies are based on Auto balancing bridge method.

Specifications

Frequency Range	20 Hz to 2 MHz
Impedance Range	0.01m Ω -99.9 m Ω
Measurement Terminals	Four-terminal pair
Accuracy Z	0.05%
D	0.0005
Output Impedance	100 Ω , \pm 3%
Measurement Time	40 m sec/190 m sec/830 msec

Applications :

- Determination of Dielectric Constant
- Power inductor characterizations
- Semiconductor C-V evaluation

Electrochemical Impedance Spectrometer (EIS)



Make: WonAtech, South Korea Model: Specification: Zive Sp5

Brief description:

- Electrochemical Impedance Spectrometer (EIS) is a powerful tool for the characterization of electrochemical systems.
- A single instrument can typically measure time constants over many orders of magnitude; in a current transient.
- This instruments have extremely good noise rejection.
- It applies only a small perturbation from steady-state, it can monitor electrochemical systems such as batteries and fuel cells in their operating conditions

Specifications

Frequency range	10 μ Hz to 1 MHz
Amplitude	1 mV to 1 Volt rms
Impedance Analysis software	ZMAN

Applications:

- Impedance study
- Battery/Supercapacitor testing
- Corrosion studies
- Mott-schottky analysis

FT-RAMAN spectrometer



Make: Bruker AXS analytical instruments Pvt. Ltd. Germany

Model: Multi-RAM

Brief description:

- Raman Spectroscopy is a method of determining modes of molecular motions, especially vibrations.
- It is predominantly applicable to the qualitative and quantitative analyses of covalently bonded molecules
- It involves the study of inelastic scattering phenomenon of light
- The combination of Raman spectroscopy with microscopic techniques allows the study of materials on the micron scale with high molecular specificity

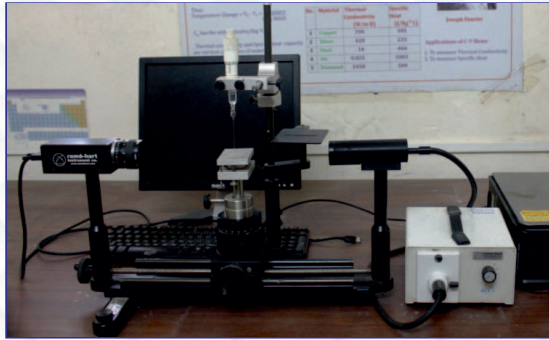
Specifications

Spectral range	3600-36 cm^{-1}
Resolution	0.8 cm^{-1}
Laser source:	Nd: YAG laser
Wavelength:	1064 nm
Sample required	Thin Film, Powder, Liquid with all solvents

Applications:

- Determine the presence of different carbon types (diamond, graphitic, amorphous carbon, carbon nanotubes)
- Identify the organic molecules, polymers, biomolecules, and inorganic compounds in the bulk and in individual particle

Contact Angle Meter



Make: Rame Hart Instruments

Model: 500-F1 Serial no. 705013

Brief description :

- It consists of Goniometer Bench with F1 series camera, LED illuminator, 3-axis stage, Microsyringe Assembly, DROP image CA software single user license
- It measures the angle formed between the solid/liquid interface and the liquid/vapor interface

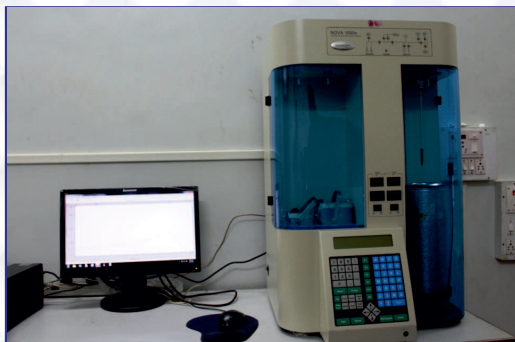
Specifications

Stage Size	2 x 3 in (51 x 76mm)
Sample Size	3 in (76mm) deep x unlimited
Contact Angle Range	0 to 180°
Resolution	0.1° Accuracy +/- 0.10

Applications :

- To determine contact angle value
- To determine surface free energy of solid sample
- Contact angle hysteresis
- Sliding angle

Surface Area Analyzer (BET)



Make: Anton paar, quanchrome instruments Mode: NOVA 1000e

Brief description:

- It helps to explain the physical adsorption of gas molecules on a solid surface
- It is an analysis technique for the measurement of the specific surface area of materials
- The BET theory applies to systems of multilayer adsorption and usually utilizes probing gases that do not chemically react with material surfaces (eg. N_2) as adsorbates to quantify specific surface area
- Nitrogen is the most commonly employed gaseous adsorbate used for surface probing by BET methods

Specifications

Operating temperature	20-300°C
Surface area range	0.1 m ² /s to no known limit
Pore size range	0.35-400nm
Accuracy (% of span)	±0.1

Applications:

It measures

- Surface area
- Average pore size
- Pore volume of all powder samples (~0.15 to 0.2 gm)

Solar Simulator



Make : Photo Emission Tech., Inc Model : CT 150 AAA

Brief description :

- A solar simulator (artificial sun) is a device that provides illumination approximating natural sunlight. The purpose of the solar simulator is to provide a controllable indoor test facility under laboratory conditions, used for the testing of solar cells, sun screen and other materials and devices.
- It provides Selectable and adjustable constant intensity or constant power mode.
- It includes Light intensity feedback system for stable light output intensity.

Specifications

Max. illuminated area	6.14" × 6.14"
Air mass	AM0, AM1 and AM1.5
Range of light intensity	100 mW/cm ² ±15%
Phase/Voltage/Frequency	Single phase/220VAC/50-60Hz
Power consumption	1.5 KVA
Operating working distance	432 nm

Applications :

- Photovoltaic cell performance
- Determining the electric performance of the photovoltaic cells
- Comparison of cell characteristics among the group of the cell
- Repeated measurement of the same cell to study the life cycle

Electrochemical Quartz Crystal Microbalance (EQCM)



Make: HORIBA Instruments Model: Fluoromax - 4

Brief description :

- The EQCM adds a valuable tool in the analytical toolbox of anyone investigating interfacial processes.
- The Electrochemical Quartz Crystal Microbalance (EQCM) is a variant of acoustic wave microsensors that are capable of ultrasensitive mass measurements.
- EQCM oscillates in a mechanically resonant shear mode under the influence of a high frequency AC electric field which is applied across the thickness of the crystal.

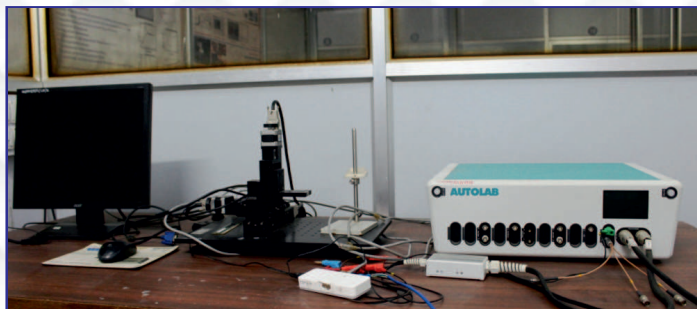
Specifications

Range	1- 10 MHz
Resolution	0.02 Hz
Operating Temperature Range	0 to 45°C
Input Voltage	10 to 14 V
Power	25W

Applications :

- Study of electrochemical processes involving electrode mass change, from the analytical, kinetic and mechanistic point of view
- Deposition/Dissolution processes
- Corrosion and Adsorption phenomena

Scanning Electrochemical Microscope (SECM)



Make: Metrohm Switerland Model: Autolab 302N with 32 FRA Sensolyte 0.045

Briefdescription:

- Scanning electrochemical microscopy (SECM) is a technique within the broader class of scanning probe microscopy (SPM) that is used to measure the local electrochemical behavior of liquid/solid, liquid/gas and liquid/liquid interfaces.
- SECM has been employed to probe the topography and surface reactivity of solid-state materials, track the dissolution kinetics of ionic crystals in aqueous environments, screen electrocatalytic prospects, elucidate enzymatic activities, and investigate dynamic transport across synthetic/natural membranes and other biophysical systems.

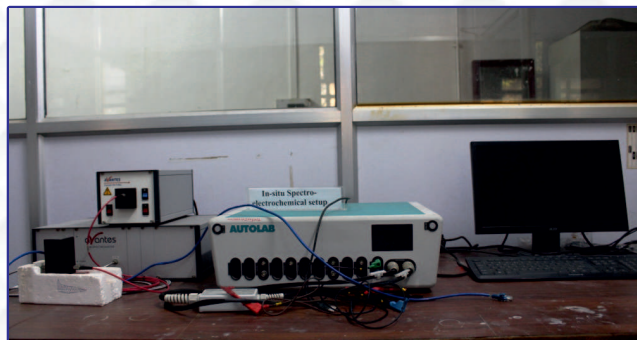
Specifications

Compliance voltage	± 30 V
Resolution 20 nm with CCD Current	± 10 nA-1A
Frequency	10 μ Hz to 32 MHz
Working area	3.5 \times 2.5 \times 2.5 cm

Applications:

- Instrumental development
- Kinetics
- Surface modification
- Energy
- Biological applications
- Corrosion

IMPS/ IMVS (In situ Spectroelectrochemistry)



Make: Anton paar, quanchrome instruments **Mode: NOVA 1000e**

Brief description:

- Spectro electro chemistry encompasses a group of techniques that allow simultaneous acquisition of spectroscopic and electrochemical information in situ in an electrochemical cell. Electrochemical reactions can be initiated by applying potentials to the working electrode, and the processes that occur are then monitored by both electrochemical and spectroscopic techniques.
- Electronic (UV-visible) transmission and reflectance spectro electrochemistry has proved to be an effective approach for studying the redox chemistry of organic, inorganic and biological molecules, for investigating reaction kinetics and mechanisms and for exploring electrode surface phenomena.

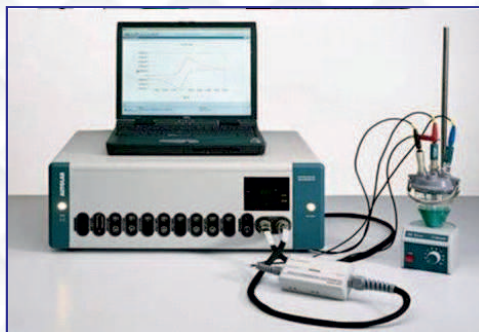
Specifications

Applied voltage	10 V
Current	1A
Wavelength range	200 to 1800 nm
Integration time	9.7 ms – 120 s
Sensitivity	3,00,000 counts/ μ W

Applications:

- Electrochromism study

Electrochemical Workstation



Make: Metrohm, Switzerland

Model: Autolab 302N with 32 FRA

Brief description:

- It is an electronic hardware which controls a three electrode cell and run most electroanalytical experiments.
- The system functions by maintaining the potential of the working electrode at a constant level with respect to the reference electrode by adjusting the current at an auxiliary electrode.
- It consists of an electric circuit which is usually described in terms of simple op amps.

Specifications

Compliance voltage	± 30 V
Resolution	20 μ V
Current	± 10 nA-1A
Frequency	10 μ Hz to 32 MHz

Applications:

- To study supercapacitive properties
- For solar cell applications (to determine IMPS and IMVS)

Spectrofluorometer (PL)



Make: HORIBA Instruments



Model: Fluoromax - 4

Brief description :

- It includes Excitation of fluorescence at multiple wavelengths caused by the excitation with light at a single wavelength.
- It measures the fluorescence or light emitted by different fluorescing objects.
- The properties of the fluorescence emission spectra are frequently used to identify substances, often including their concentrations, and in other cases properties of a medium which influence details of the fluorescence.

Specifications

Excitation	200-950 nm
Emission	200-950 nm
Wavelength Accuracy	+ 0.5 nm
Scan Speed	80 nm/s
Signal to noise ratio	3000:1 (Steady-state-mode)

Applications :

- Sensing application such as gas sensors and biosensors
- DNA detection
- Accurate determination of glucose
- Study of Marine Petroleum Pollutants
- Detection of bacterial biofilms

Surface Profiler



Make : Ambios technology(USA)

Model : XP-1

Brief description :

- Advanced computer controlled Stylus Profiling System for morphology/topography characterization of samples
- The XP-1 uses a diamond stylus to lightly contact the surface
- The profiler incorporates an optical deflection height measurement mechanism and magneto static force control system

Specifications

Sample stage diameter	170mm
Lateral resolution	100nm
Operating temperature	11 to 21°C
Vertical resolution	1.5Å
Max Power Requirements	220V

Applications :

- Measures roughness, waviness and height (thickness) in variety of application
- Ability to measure precision step height from 10 angstroms to 100 microns

UV-Vis Spectrophotometer



Make : Shimadzu

Model : UV-1800

Brief description :

- UV-VIS spectrophotometer is used to measure transmittance properties of the films as well as liquids as a function of wavelength
- Its double beam optics ensures good stability and easy reference. It is interfaced with computer with the help of Uv-Win software which adds many additional functions to analyse data
- The deuterium and tungsten lamps are used as source and silicon photo diode is used as detector

Specifications

Wavelength range	190 to 1100 nm
Operating temperature	15 to 35°C
Measurement modes	Spectrum, Kinetics & Photometric
Required sample size	33mm x 30mm x 2mm thick
Noise level	<700nm

Applications :

- Determination of absorbance and transmittance of the sample under study
- Determination of impurities
- Quantitative and qualitative analysis

Electrometer



Make: KEITHLEY

Model: Keithley-6514

Brief description :

- The Model 6514 Electrometer combines flexible interfacing capabilities with current sensitivity, charge measurement capabilities, resolution and speed
- The 5½-digit Model 6514 is designed for applications that demand fast, yet precise measurements of low currents, voltages from high resistance sources, charges, or high resistances

Input impedance on voltage measurements	200T Ω
Charge measurements range	10f C to 20 μ C
Maximum speed	up to 1200 readings/second

Applications :

- High resistivity measurements
- Leakage currents
- Ion selective electrode measurements
- pH measurements
- Conductivity cells
- Potentiometry



Physics Instrumentation Facility Centre (PIFC)
Department of Physics,
Shivaji University, Kolhapur

(Note: Please bring a C.D. for collecting data)

W.O. No.:

Date:

1. Department/college/other party : _____ :
2. Name of Research student : _____ :
3. Name of Guide: _____ :
4. Instrument to be used: XRD, Atomic Force Microscope, SEM, Solar Simulator Electrochemical workstation, Spectrofluorometer (Photoluminescence with thin film attachment), LCR Bridge, Contact angle meter, Surface profiler, EQCM, FT Raman, FE-SEM, Electrochemical workstation with IMPS and IMVS and spectroelectrochemical set up, Scanning electrochemical microscope, Ultrasonic spraying system, Thermal CVD, Thermal Conductivity meter
5. No. & Nature of the sample (Whether conducting or non-conducting) _____
6. Work to be performed on: _____ :
7. Budget Head: _____ :

Sign of Student

Sign of Guide

Head of Institution

For Office Use Only

Teacher-in-charge

Coordinator, PIFC

Head, Dept. of Physics

Date and time allotted :

Date and time of work completion:

Signature of Operator and Remarks :



— • Contact us • —

Prof. (Dr.) K. Y. Rajpure

Prof. & Head, Department of Physics
Shivaji University, Kolhapur - 416 004. (India)

Email: physics@unishivaji.ac.in

Phone: 0231-2609227

www.unishivaji.ac.in/sspifc/