

## X-ray Photoelectron Spectroscopy Facility [ Lab No. 110 ]



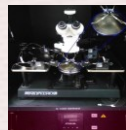
### X-ray Photoelectron Spectroscopy (XPS) with Auger Electron Spectroscopy (AES)

XPS is used for surface characterization of range of materials (both conducting and non-conducting) including inorganic compounds in powder form. Its unique feature is that it can detect all elements within 0.01 monolayers of surface starting from atomic number of 3 (lithium) and above. The ultimate spatial resolution for spectroscopy and mapping is less than 10  $\mu\text{m}$ . The high micro area sensitivity makes possible depth profiling with small diameter x-ray beams.

## Electrical Characterization Facilities [ Lab No. 201 ]

### Probe Station (RT to High Temp)

The Probe Station can be used for measurement of electrical characteristics with help of Semiconductor Parameter Analyzer from ambient temperature to 300  $^{\circ}\text{C}$ . It comes with two and four micromanipulators along with dedicated coaxial cables.



### Cryogenic Probe Station (Low Temp)

This probe station is dedicated for low temperature range of 10K - 350K. It comes with four micromanipulators with triaxial cables. Also with an optical arm for LASER excitation of samples.



### Hall Effect Measurement System

This table top Hall Effect system has capability to measure resistivity, type of conductivity, mobility and doping level in a material. It has a permanent magnet with a magnetic-field strength of  $0.55 \pm 0.03$  Tesla. It can measure the properties over a wide temperature range of 80 K - 350 K.

### Impedance Analyzer

The Impedance Analyzer is used for corrosion studies, battery research, LCDs, biomaterials, electronic component development. It comes with wide frequency range of spanning 10  $\mu\text{Hz}$  to 32 MHz with 0.015 ppm resolution, and also provides excellent coverage for chemical and molecular mechanisms. It precisely measures impedances >100 MO. It comes with 2,3 & 4 terminal measurement configurations with polarization voltage range up to  $\pm 40.95$  V.

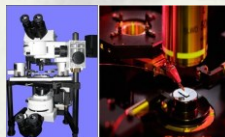


### Piezo/Ferro/Pyro-electric materials characterization

This instrument has capability to measure Dynamic-Hysteresis, Pulse, Static-Hysteresis, Leakage-Current, Fatigue, Retention, and Imprint. It comes with an internal heater with a temperature range of 20 to 800  $^{\circ}\text{C}$ . Use of silicon oil possible to increase the flash-over voltage. For thin film, temp range is 20 to 250  $^{\circ}\text{C}$ .

### Near Field Scanning Optical Microscope (NSOM)

Multimodal NSOM provides simultaneous measurements of the topography and direct correlation between surface nano-features with resolution less than 50 nm and optical/electronic properties. The multiple modes are: Collection Mode (res 10-20 nm), Transmission Mode (lateral dimension 2-5 nm), Apertureless NSOM Near-field Illumination & Near-field Scattering and/or Collection with Multiple AFM/NSOM probes.



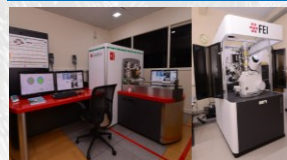
## Magnetic Characterization Facility [ Lab No. 102 ]

### Superconducting Quantum Interference Device Magnetometer (SQUID)



The lab has two instruments, first is Vibrating Sample Magnetometer (VSM) which measures magnetic properties (hysteresis curve) based on Faraday's Law of Induction. And second is SQUID Magnetometer which has capability of measuring magnetic properties at a wide range of temperature, 4 to 300 K (Cryogenic) and 300-700 K (with oven insert). It has range of magnetic field up to 6.5 Tesla. It can measure DC measurement (M-T, M-H) and AC measurement ( $\chi'$  and  $\chi''$ ) within frequency range of 0 to 3 kHz.

## National Facility For Atomic Probe Tomography [ Lab No. 112 ]



National Facility for Atomic Probe Tomography (NFAPT) houses the state of art atom probe tomography (APT) facility, which has latest cutting edge technology "Local Electrode Atom Probe (LEAP 5000 XR)" along with "Helios Dual Beam Scanning Electron Microscope with Focussed Ion Beam (FIB)" for sample preparation. A sharp tip sample is prepared using Focused Ion Beam (FIB) and LEAP allows characterising the samples ( $50 \times 150 \times 500 \text{ nm}^3$ ) at the sub nanometer spatial resolution by providing 3D atom-by-atom imaging and chemical information using time of flight mass spectrometry. APT exhibits extraordinary capabilities such as atomic resolution (lateral resolution: 0.3-0.5 nm and depth resolution 0.1-0.3 nm), 3D information about the position of the each atom in the analysed sample and chemical sensitivity down to atomic parts per million.

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XRF-IRMS [Lab No. 101]	Convenor: Prof. Debajyoti Paul Staff: Mr. Abhishek Kumar (krabhis@iitk.ac.in, 7780)

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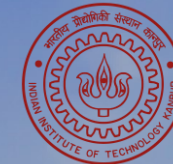
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Designed by Anoop Raut

## Information Booklet



**ACMS**  
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भारतीय प्रौद्योगिकी संस्थान कानपुर  
Advanced Centre for Materials Science  
Indian Institute of Technology Kanpur



## Wide Range of Facilities In-house

- ❖ Scanning Electron Microscope (W-SEM, FEI, FEG-SEM, EPMA)
- ❖ Powder XRD, Two-Circle/Four-Circle Diffractometer
- ❖ X-ray Photoelectron Spectroscopy (XPS) with Auger Electron Spectroscopy (AES)
- ❖ Thermal Analysis (High Temp. Simultaneous Thermo Gravimetric Analyzer (TGA), Differential Scanning Calorimetry (DSC), BET Surface Area Analyzer)
- ❖ Electrical Characterization (Probe Station, Semiconductor Analyzer, Hall Effect, Sheet Resistance, Thermo/Piezo/Ferro/Pyro-Electric Characterization, Closed-Cycle Cryostat, Impedance Analyzer, Near Field Scanning Optical Microscope)
- ❖ Mechanical Testing Facilities for Tensile, Compression, Bending, VAFCP/Fatigue Testing, Slow-Strain-Rate, Creep and Impact Testing
- ❖ Instrumented Indentation (Universal/Micro/Nano)
- ❖ Advanced High Sensitive Spectral Confocal and Multiphoton Microscope System for Live Cell Imaging
- ❖ X-Ray Fluorescence Spectrometer, Stable Isotope Ratio Mass Spectrometer (IRMS), Glass Bead Making

*One stop solution for all your  
Material Characterization needs*



# LIST OF EQUIPMENTS

## Electron Microscopy Facilities [ Lab No. 112 ]

### Field Emission-Scanning Electron Microscopy (FE-SEM) with Orientation Imaging Microscopy (OIM)

This FE-SEM is capable for high resolution secondary as well as backscattered electron images. It is equipped with SE, BSE and EDS detector in addition to EBSD, tensile stage module and a heating stage. With EBSD based Orientation Indexing Microscopy (OIM), the equipment has an unmatched capability of micro-texture analysis. **Additional Capability:** With a tensile stage it is possible to carry out *in-situ* tensile testing with a heating stage (till 500 °C). It has SE Resolution upto 3 nm at 15 kV/5 nA, and magnification range till 1000,000x and an accelerating Voltage range till 30 kV.



### Electron Probe Micro-Analyser (EPMA)



This is a W/Lab6 based EPMA with 4 channels for WDS analysis along with an EDS detector for the fast analysis of multi-component alloys and minerals. It is best suited for accurate micro-composition analysis (standard/standardless) in point, line or area scan modes. Elemental mapping with high resolution can be done with both WDS and EDS techniques. Quantitative analysis of all elements from B to U is possible. It has an accelerating voltage range from 0.2 to 30 kV. Probe current range from  $10^{-12}$  to  $10^{-5}$  nA along with probe current stability of  $\pm 0.05\%$ /h. It comes with SE Image Resolution up to 5 nm. It can detect WDS wavelength in range of 0.087 to 9.3 nm.

### Tungsten-Electron Microscope (W-SEM)

This is a compact SEM for the quick image analysis with high resolution and compositional information. The integral EDS detector can be used for micro-compositional analysis. It comes with: BSE Resolution of 5 nm at 20 kV. Magnification range till 300,000x. Accelerating voltage from 0.5 to 20 kV. Automatic SEM condition set-up based on sample type.



### Tungsten-Electron Microscope, FEI-Quanta

The lab has another W-SEM from FEI-Quanta which is suitable for an extensive image analysis with high-resolution. It has SE resolution better than 2.0 nm at 20 kV and magnification range till 500,000x. It also supports biological and polymeric samples. The diversified specimens category makes it an excellent choice for many users from different research backgrounds.

## X-Rays Diffraction Facilities [ Lab No. 106 ]

### X-Ray Diffractometer (XRD), Panalytical

This XRD is capable of ultra-fast X-ray diffraction on bulk and powder samples using line detector (with *in-situ* high temperature stage, limited Small Angle X-Ray Scattering and thin film capability). Maximum usable range is  $-40^\circ < 2\theta < 160^\circ$ .



### Two Circle Diffractometer

Rigaku MiniFlex 600 for routine polycrystalline X-Ray Diffraction (phase determination, precise lattice parameter determination, crystallite size and strain determination).

### Four Circle Diffractometer (Rigaku)

This four circle diffractometer offers a high resolution X-ray diffraction tool for routine phase analysis, crystalline and micro-strain measurement, grazing incidence diffraction, small angle scattering. It also offers niche experiments that include texture and residual stress measurement with micro-focus source, X-ray reflectivity, Rocking Curve and Reciprocal Space Mapping for epitaxial thin films.



## Thermal Facilities [ Lab No. 108A/113/102 ]

### High Temperature Thermo-Gravimetric Analyzer (TGA) and Differential Scanning Calorimetry (DSC)

This TGA has capability for thermal analysis for range of crystalline and non-crystalline materials to understand the kinetics and thermodynamics of various phase transformations. DSC can measure heat change, amount of heat, temperature for transformation and activation energy. It has the calorimetric sensitivity of 0.2  $\mu$ W with an accuracy of heat flow 0.2 %. It comes with dynamic range of calorimeter (up to 1300 mW). Temperature range is from RT to 995 °C. It has precise heating and cooling rates.



### Differential Scanning Calorimeter (DSC 8000)

This DSC has double furnace technology, which directly measures the heat flow difference between two independent furnaces. This design gives higher accuracy and sensitivity for even your most demanding applications. It has calorimetric dynamic range of  $\pm 1300$  mW with accuracy of  $< \pm 0.2$  % and precision of  $< \pm 0.03$  % and sensitivity of 0.2  $\mu$ W. It come with controlled heating and cooling rates with temperature performance range of -180 °C to 750 °C.



### BET Surface Area Analyzer

The BET uses physisorption techniques for determination of surface area and pore structure. The system characterizes samples with Nitrogen as the standard adsorptive gas and can analyse materials with low surface areas and micropores (5 to 15 Å) using Krypton and other adsorptive gases. The system is capable to perform automatic single-point and multi-point BET surface area, Langmuir surface area, full adsorption and desorption isotherms, pore size and pore volume distribution. It is equipped with chemisorption analysis, thermal programming oxidation, reduction, and desorption.

## XRF Facility [ Lab No. 101 ]



### X-Ray Fluorescence Spectrometer (XRF)

This WD-XRF Machine can be used for detecting the elements using non-destructive analysis technique for the major oxides and trace elements present in metals & alloys, Geological samples, Chemicals, Ceramics etc. It can cover elements from Beryllium to Uranium.

The concentration range goes from 1 ppm to 100 wt%. Analysis can be done on pressed powder pellets or Glass beads (10-30 mm dia) made from fine powder (particle size 50 $\mu$ ).

### Stable Isotope Ratio Mass Spectrometer (IRMS)

This IRMS system can be used for analyses of variety of inorganic and organic samples like carbonate samples, gaseous species, dissolved inorganic carbon, and for water isotope. The IRMS is coupled with an Elemental Analyzer (Flash EA2000) and Gas-Bench-II. The Elemental Analyzer has an automated solid sampler used to combust solid inorganic/organic samples in continuous-flow for  $\delta^{13}C$  and  $\delta^{15}N$  analysis. The Gas Bench system is used for temperature dependent carbonate-acid reaction and extraction of  $CO_2$  gas, which is subsequently measured for  $\delta^{13}C$  and  $\delta^{18}O$  values.



## Live-cell Imaging Facility [ Lab No. 209 ]



### Advanced High Sensitive Spectral Confocal and Multiphoton Microscope System for Live Cell Imaging

The Live-cell Imaging facility includes: (i) a high-end inverted fluorescence microscope with onstage incubator for cell culture; (ii) programmable X, Y and Z scans for capturing bright field and fluorescence imaging for DAPI,

Rhodamine, TRITC, FITC, GFP, YFP, and CFP using high resolution Peltier cooled monochrome camera. The system is supported with tuneable femtosecond laser source (690-1040 nm) with PMT and GaAsP modules for signal detection. In addition, it has an incubator and bio-safety cabinet for handling of mammalian cell and tissue cultures.

## Indentation and Profilometry Facilities [ Lab No. 112/110-A ]



### Nano Indenter with in-situ Scanning Probe Microscopy (SPM)

This is a Nano-Mechanical Testing System with modules mapping capability. It can be used for Nanotribology studies, e.g. scratching at different loads, wear volume, coefficient of friction. It can analyse coating lifetime. It has loss and storage modules and damping measurement capability. Indent and wear track imaging can also be done.

### Instrumented Micro-Indentation

This instrumented micro-indentation instrument can perform Vickers and Rockwell micro hardness testing with an additional option for testing in a controlled temperature environment ranging from ambient temperature to 450 °C.



### Optical Profilometer

Optical Profilometer are interference microscopes used for accurate surface measurements. It measures height variations such as surface roughness on surface using the wavelength of light as the ruler. With use of 3D mapping it can perform analysis of  $R_z$  statistics, step height, surface area and volume. This profilometer version comes with dual-LED illuminated optical module with objective of 20x, 50x and 2.5x. It has a motorized XY stage with automated scan range up to 10mm with resolution of  $< 0.01$  mm.

### Optical Emission Spectroscopy (OES)

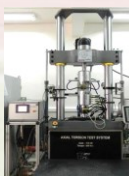
This arc/spark OES analyser is widely used to determine the elemental composition of a broad range of metals (Lithium to Uranium) that uses the light emitted (arc/spark) on an excited element falling in range of visible emission spectrum. It can also determine the concentration of the considered element. It is equipped to achieve fast, accurate elemental analysis precisely tuned for material control and foundry applications



## Mechanical Testing Facilities [ Lab No. 104 ]

### 100 kN Hydraulic Universal Testing Machine (UTM)

A modern-day 100 kN servo-hydraulic UTM, best suitable for all the testing requirements under dynamic loading condition for tests like Fatigue, VAFCP, JIC/KIC. It also accompanied with an environmental chamber dedicated to maintain the low temperature ( $-20$  °C) and humidity controlled test environment.



### Axial Torsion Testing System

This 100 kN servo-hydraulic UTM is capable to apply tension-torsion load on test specimen to study the monotonic deformation of variety of materials from polymers to superalloys. The instrument is additionally equipped with an induction heating furnace unit (upto 1000 °C) with a controlled heating rate for testing the metal alloys with a real-time localised heating.

### High Temperature Creep Testing Stations

A pair of 50 kN electrically actuated creep testing station dedicated for high temperature tensile/creep testing. It has two separate stations with two different furnaces attached ranging till 1000 °C and 1600 °C, to run the two samples simultaneously. It comes with ceramic rod extensometer for the accurate strain measurement.



### Slow Strain Rate Testing Stations

This is a 50 kN electrically-actuated machine devoted for stress-corrosion testing running at slow strain rate up to  $10^{-7}$  s $^{-1}$  on samples submerged in a corrosive solution bath chamber. It has two separate units, one with vertical mounting and another with horizontal mounting.



### And Many More..!

Please visit the acms website for the detailed info about these and other unlisted instruments.