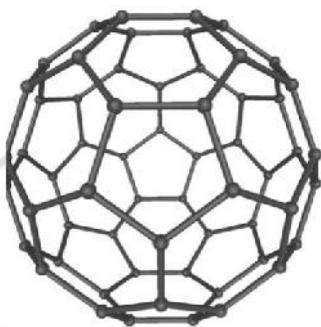


MATERIALS RESEARCH CENTRE MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY, JAIPUR

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MATERIALS RESEARCH CENTRE



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Transmission Electron Microscope



1. The Tecnai G² 20 (FEI) S-Twin is a 200 kV transmission electron microscope designed to offer high resolution imaging and analysis solution for life sciences, materials science, nanotechnology and the semiconductor and data storage industries.
2. The Tecnai G² supports a wide range of techniques including high resolution scanning S/TEM diffraction and chemical analysis. The on axis BF/DF detectors provide the Z-contrast imaging.
3. The high angle, annular dark field detector generates atomic resolution dark field STEM images. The equipment provides a point resolution of 0.24 nm, line resolution of 0.14 nm and STEM resolution of 1.0 nm. EDAX gives the elemental composition of material.

Applications:

- Life sciences
- Materials science
- Nanotechnology
- Semiconductors
- Data storage industries

Multi Mode Scanning Probe Microscope



1. **Multimode Scanning Probe Microscope (Bruker)** has all standard operating modes like SPM, AFM, MFM, LFM, TM, TR nanoindentation, lithography and many unique capabilities to characterize everything from mechanical to electrical properties at high resolution.

Applications:

- Electrical property mapping (current and capacitance)
- Direct mapping of nanomechanical properties, including elastic modulus, adhesion and dissipation, at high resolution and normal scan rates

Field Emission Gun SEM



1. Nova Nano FE-SEM 450 (FEI) provides ultra high resolution characterization & analysis giving precise, true nanometer scale information.
2. Advanced optics & detection, including beam deceleration, in lens ETD(SE), TLD (custom), lens mounted DBS & LVD offer best selection of information & image optimization. Beam landing energy can go down from 30 keV to 50 eV.
3. It gives a resolution of 1.4 nm at 1 kV (TLD-SE) & 1 nm at 15 kV (TLD-SE). The FE-SEM is coupled to EDAX detector for measuring the elemental chemical composition of materials.

Applications:

- Metallic materials
- Ceramics and composites
- Polymeric materials
- Geology and mineralogy
- Dental materials

X-Ray Diffractometer



1. The X-Ray Diffractometer (Panalytical X Pert Pro) is a versatile equipment designed for a wide variety of applications in X-ray diffraction analysis on powders, thin films, epitaxial layers, machined materials, ceramics etc.
2. The use of pre FIX optical modules, sample platform & tube rotation feature enable the user to change the system from a high resolution or stress texture point focus application to a normal Bragg-Brentano line focus configuration or a reflectometry system.

Applications:

- Determination of crystal structure(phase crystallinity, Bragg's plane, particle size)
- Quantitative texture analysis
- Preferred orientation studies
- Reflection topography etc

Nuclear Magnetic Resonance Spectrometer



ECS-400 NMR System

Applications:

- Determination of the content and purity of a sample through space connectivity (Overhauser effect)
- Chemical dynamics (Line shapes, relaxation phenomena)
- 1D, 2D (COSY, NOESY, HETCOR, DEPT, HMQC etc.)

1. ECS 400 MHz (JEOL) NMR spectrometer is a 2-channel console with a flexible broad band RF performance.
2. Capable of providing spectra of a variety of NMR-active nuclei such as ^1H , ^{13}C , ^{19}F and metals like Sn, Cu in distinct chemical environments without any time delay. Low temperature accessory permits variable temperature.

Mass Spectrometer



1. **Xevo G2-S Q Tof (Waters, USA)** provides a wide range of mass analysis of small organic/inorganic/ organometallic compounds to large polymeric & proteomics samples including proteins & peptides.
2. The Q Tof technology in this instrument provides superior UPLC-compatible mass resolution, matrix-tolerant dynamic range, quantitative performance, simultaneous mass accuracy and speed of analysis. Fast data directed analysis allows full structural characterization of unknown compounds.
3. The UPLC/MS data acquisition comprehensively catalogs complex samples in a single analysis. Universal Ion Source Architecture enables the most extensive range of interface capabilities to service the broadest range of applications.
4. LC/MS, MS/MS, HRMS analysis of liquid and samples up to a range of m/z 1,00,000 is available with detail mass analysis.

Applications:

- Environmental
- Life Sciences and Pharmaceuticals
- Chemical
- Food

Abrasive Cutter



1. The AbrasiMatic® 300 (Buehler) abrasive cutter is a bench-top cutter featuring manual cutting action in 3 directions & automated cutting in 1 direction.
2. This gives the user the maximum versatility to section a wide variety of sample materials, sizes and geometries. It is engineered with innovative capabilities to be used in both production support and laboratory environments.

Applications:

Cutting of :

- steel
- highly-alloyed metals
- coated metals
- ceramics
- concrete and minerals

High Speed Diamond Cutter



1. Isomet 4000 (Buehler) is a versatile linear precision saw which enables to cut all kind of delicate specimen with minimal damage due to deformation.
2. Wheel speed upto 5000 rpm and can cut specimen of 0.2mm thickness.

Applications:

- Tool capable of cutting virtually any material, including brittle and ductile metals, ceramics, composites, cements, laminates, plastics, electronic components and biomaterials

Hot Mounting Press



1. Simplimet 3000 (Buehler) Automatic Mounting Press is a durable press with basic features that provide effective mounting, increases productivity and specimen consistency verses manual mounting press.
2. Electrohydraulic operation requires no air. Enhanced features include 25 user definable methods and thermoplastic parameters.

Applications:

- Can mount Metallurgical, Petro graphic and other Materials for Micro structural Analysis

Automatic Polishing Machine



1. The EcoMet 250 Grinder-Polishers has been designed to meet the needs of the materials analyst requiring the versatility of manual or automated sample preparation.
2. The EcoMet Provide controls upgrade to a color touch-screen control panel for Z-axis material removal by depth, method creation/storage and automated dispenser programmability.

Applications:

- Automatic grinding and polishing
- Micro structural Analysis

Semi-Automatic Polishing Machine



1. MetaServ® 250 (Buehler) High Speed Twin grinder-polishers offer a combination of performance, economy and reliability for most microstructural analysis applications. The platen diameter is 8 inch with 50-500 rpm speed in 10 rpm increment
2. A built-in drain and bowl wash flush out particles and minimize build-up of grinding-polishing debris. The adjustable water flow nozzle can be positioned anywhere over the platen, providing cooling precisely where needed.

Applications:

- Micro structural Analysis
- High Speed grinding

Hot Plate



1. Model 623-40(Gatan) specimen mounting Hot Plate is thermostatically controlled at the precise mounting temperature of 130° C.
2. The Hot plate contains recesses to hold the specimen mounts in place when bonding the disc.

Applications:

- For preparing 3 mm metallic disc of thickness less than 200 μm

Dimple Grinder With Stereomicroscope

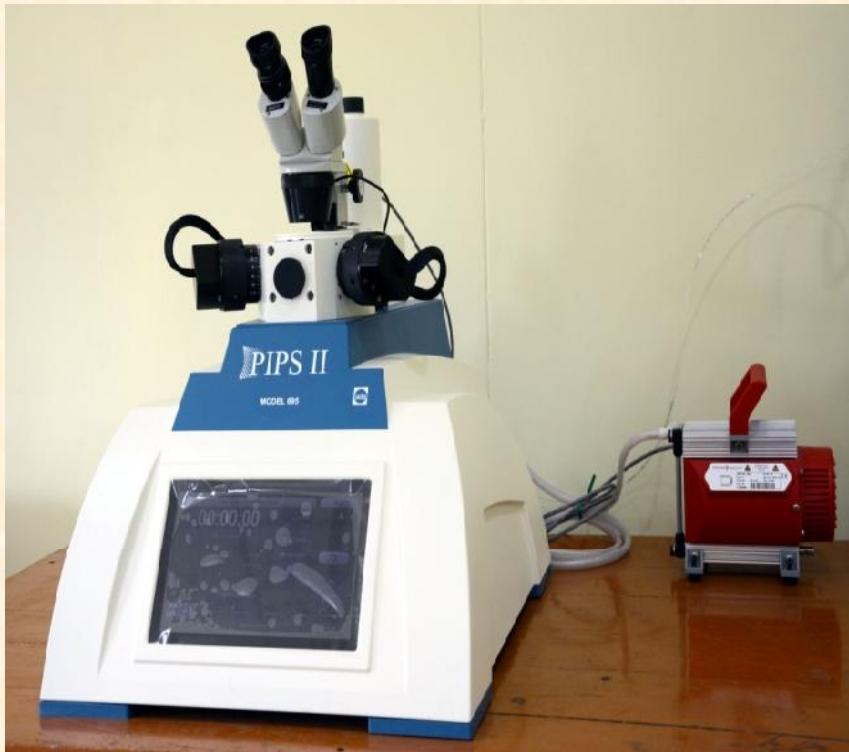


1. **Model 656 (Gatan) Dimple Grinder** can reduce, with minimal damage, the central region of a typical 100 μm thick, 3 mm diameter specimen blank to a few microns in times ranging from 20 minutes for silicon to 100 minutes for sapphire.

Applications:

- Direct preparation of TEM Specimens
- Micro positioning of specimens
- Improved auger profiling for specimens
- Accurate depth and thickness control for dimples

Ion Beam Milling



- 1. PIPS II incorporates the patented Whisperlok ® with the X, Y positioning stage for precise centering of the milling target. The PIPS II incorporates a 10 inch touch screen for ease of use and increased control and reproducibility of the milling process.**
- 2. The Digital Zoom Microscope monitors the polishing process and the color images can be stored in Gatan's Digital Micrograph ® software for review and analysis while the sample is in the TEM.**

Applications:

Preparation of TEM samples of
•Metals (Oxide, alloys), Ceramics etc.

Twin Jet Tenupol



1. TenuPol-5 (Struers) is capable of preparing a perforated specimen for transmission electron microscope from a sample of 3 mm diameter in just a few minutes.
2. The specimen is polished from both sides simultaneously providing a structure with a minimum of deformation.
3. When the perforation appears, the polishing can automatically be stopped by the infrared detector system. Electrolytic pre-thinning or blanking can also easily be carried out.

Applications:

- Electrolytic Polishing
- Chemical Thinning

Planetary Ball Mill



- 1. PULVERISETTE 6 (Fritsch) Planetary Ball Mill for mixing and perfect homogenising of emulsions or pastes.**
- 2. Maximum output sample quantity: 125 ml with maximum 600 rpm .**

Applications:

- Chemistry
- Metals
- Ceramics
- Medicine
- Nuclear research
- Materials technology

Ultra Sonicator



1. Ultramet 2005 (Buehler) with a 9.5L capacity quickly cleans samples to prepare for the next preparation step.
2. Faster and more consistent than other methods, samples are immersed in solution and saturated with ultra high frequency sound waves cleaning difficult to reach areas, cracks and irregular surfaces.
3. Features a 60 minute timer and continuous clean mode.

Applications:

- Cleaning of specimens for test

Fluorescence Spectrometer



1. The LS 55 (Perkin Elmer) Fluorescence spectrometer provides all types of data applications that require fluorescence, phosphorescence, bioluminescence, chemiluminescence etc. with excitation range of 200-800nm.

Applications:

- Cell based Cytotoxicity, cell viability, cell quantification, cell proliferation, adhesion, and reporter gene expression, apoptosis, Clinical Enzyme and substrate assays, porphyrins, steroids, blood flow.
- Environmental Pesticide detection on many substrates including leaves, ground water tracing, oil contamination of fresh and marine water, EROD assays, chlorophyll determination of normal and toxic algae.
- Pharmaceutical Vitamins, biogenic amines, pharmaceutical and abuse drugs, toxicity assays, cell function assays.
- Inorganic Aluminium, lead, magnesium, manganese, selenium, tin, zinc.

Fourier Transform Infrared spectrometer

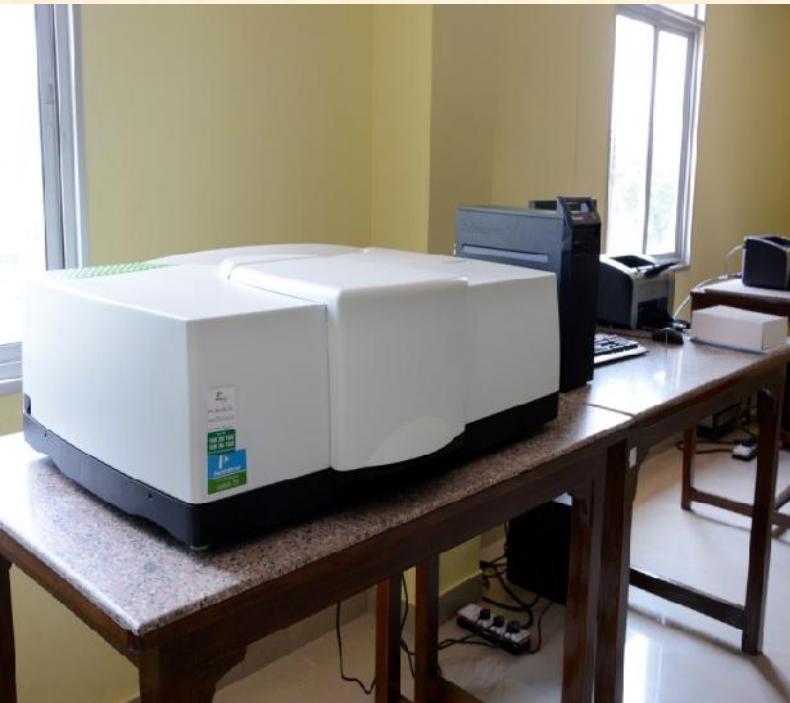


1. **FT-IR Spectrum 2 (Perkin Elmer)** is a compact, easy to use, powerful instrument with fully integrated, universal sampling system for measurements in the range of $4100\text{-}400\text{ cm}^{-1}$ for liquid (in KBr cell) and solid (in KBr pellets) samples.

Applications:

- Pharmaceuticals and Nutraceuticals
- IR sampling, spectral and field based analysis.
- Polymers
- Environmental
- In-service lubricants and fuels

UV-VIS NIR spectrophotometer



1. LAMBDA 750 (Perkin Elmer) UV-Vis NIR Spectrophotometer instrument is a bench-top, true double-beam, double-monochromator design providing high stability & accuracy performance for samples in the area of chemical sciences, biochemistry, materials science, nanoscience and technology.

Applications:

- Application areas range from surface characterization of solids to the photometric analysis of turbid, colloidal, transparent and translucent samples.
- Typical uses encompass quality assurance testing and product development measurements on textiles, dyes, paper and glass.

Dynamic Mechanical Analyzer



1. DMA 8000 (Perkin Elmer) is a technique widely used to characterize a materials properties as a function of temperature, time, frequency, stress, atmosphere or a combination of these parameters.
2. Ideal for advanced research and routine quality testing in the polymers, composites, pharmaceutical, and food industries.

Applications:

- Moisture induced phase transitions
- Moisture sensitive materials like paper, natural fibers and food products
- Swelling, shrinking and stiffness changes as humidity changes
- Plasticizing and Tg effects as seen in nylon and polyurethanes

TGA-DTA



1. The STA 6000 (Perkin Elmer) features the innovative SaTurn A Sensor for high quality, simultaneous TG and DTA measurements.
2. This advanced sensor is optimized to achieve flat DTA baselines and high sensitivity. Both sample and reference are measured simultaneously.
3. The corrosion-resistant, pure platinum pan holder and reference ring make the instrument suitable for a wide variety of samples and applications.

Applications:

- Oxidative stabilities
- Thermal stabilities
- Glass transition temperatures
- Transition and reaction enthalpies

High Vacuum Thermal Coating



1. **High Vacuum Thermal/ e-beam Coating Unit (Model BC-300 HHV)** is a versatile coating unit for thin film applications with facilities for evaporation, glow discharge cleaning etc.
2. The system offers a variable source to target distance of 30cm-80cm & uniform deposition over 3 cm diameter.
3. The temperature of the substrate can be varied from 27 °C to 550 °C possible deposition materials are all semiconductors, oxides & metals.

Applications:

- Protective coatings, Interference Filters
- Reflection & Anti-reflection layers
- Anti-corrosive layers
- Electrically conductive & Transparent coatings
- Contact layers

Microwave Reactor



1. Microwave reactors (**CEM Discover**) opens avenues for a wide range of conditions and variables to be investigated. The reactions can be run up to 300°C and 300 psi in 10-mL to 80-mL sealed vessels. Additionally, open-vessel reactions can be run using conventional round-bottom flasks (up to 125 mL) equipped with a reflux condenser.

Applications:

- Opening of new reaction pathways
- Increase in yields in difficult chemistries
- Increase of purity profiles/selectivity in product mixtures
- Decrease of reaction times from hours or days to minutes

Spin Coater



1. Spin Coating System (APEX) is an indispensable tool for fabricating thin films on a suitable substrate with 5000 .rpm

Applications:

- Thin film coatings on semiconductors/ metals & glass
- Casting of organic films
- Micro circuiting etc

Chemical Vapour Deposition



- I. Thermal chemical vapour deposition unit (Technos Instruments) is an economical R&D system with uniform heating zone providing process solutions for production of single & multi walled carbon nanotube (SWCNT & MWCNT respectively) using fixed bed method.

Applications:

- CNT growth for various devices
- Fluidity
- Carbon fiber and particles

Vacuum Impregnator



1. Cast n' Vac 1000 (Buehler) evacuates entrapped air from specimens. Without the presence of air, the mounting compound fills the specimen pores and eliminates gaps between the specimen and the compound.
2. As a result, edge retention is enhanced and friable samples are supported during grinding and polishing.

Applications:

- Providing vacuum to eliminate gaps between specimens and compound

Semiconductor Device Parameter Analyzer



1. Semiconductor Device Analyzer (Agilent B1500A) integrates multiple measurement and analysis capabilities for accurate and quick device characterization into a single instrument.
2. It is the only parameter analyzer with the versatility to provide both a wide range of device characterization capabilities along with uncompromised measurement reliability and repeatability.
3. It supports all aspects of measurement, from fundamental current-voltage (IV) and capacitance-voltage (CV) characterization up to state-of-the-art fast pulsed IV testing.
4. In addition, the B1500A's ten-slot modular architecture allows you to add or upgrade measurement modules if measurement needs change over time.

Applications:

- CMOS Transistor: I_d - V_g , I_d - V_d , V_{th} , breakdown, capacitance, QSCV, etc.
- Bipolar Junction Transistor (BJT): I_c - V_c , diode, Gummel plot, breakdown, h_{fe} , capacitance, etc.
- Discrete device: I_d - V_g , I_d - V_d , I_c - V_c , diode, etc.
- Memory: V_{th} , capacitance, endurance test, etc.

COMSOL : Multiphysics Software

- I. COMSOL Multiphysics is a finite element analysis, solver and Simulation software /FEA Software package for various physics and engineering applications, especially coupled phenomena, or multiphysics.

The following modules (31) are available in MRC

AC/DC Module, Acoustics Module, Batteries & Fuel Cells Module, CAD Import Module, CFD Module, Chemical Reaction Engineering Module, Corrosion Module, ECAD Import Module, Electrochemistry Module, Electrodeposition Module, Fatigue Module, Geomechanics Module, Heat Transfer Module, Live Link Products for CAD, LiveLink for MATLAB, LiveLink for Excel, Material Library, MEMS Module, Microfluidics Module, Molecular Flow Module, Multibody Dynamics Module, Nonlinear Structural Materials Module, Optimization Module, Particle Tracing Module, Pipe Flow Module, Plasma Module, RF Module, Semiconductor Module, Structural Mechanics Module, Subsurface Flow Module, Wave Optics Module.

IC Cap Device Software

1. Integrated Circuit Characterization and Analysis Program (IC-CAP) is the industry standard for DC and RF semiconductor device modeling. IC-CAP extracts accurate compact models used in high speed/digital, analog and power RF applications.
2. The most advanced semiconductor foundries and IDMs rely on IC-CAP for modeling silicon CMOS, Bipolar, compound gallium arsenide (GaAs), gallium nitride (GaN) and many other device technologies. IC-CAP is the most advanced, customizable modeling software and includes measurement, simulation, optimization and statistical analysis tools.

Applications

- Open software architecture enables maximum accuracy and provides ultimate flexibility to create and automate measurement, extraction and verification procedures
- Turnkey extraction solutions for industry standard CMOS models, such as BSIM3/BSIM4, PSP and HiSIM, minimize the learning curve and maximize model accuracy
- Most direct links to commercial simulators ensure consistency between extracted models and the simulators used by circuit designers