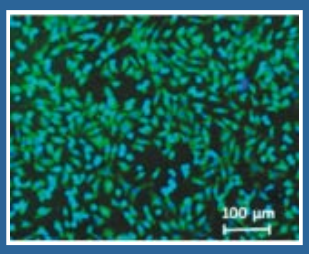
INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

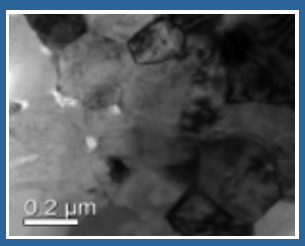
LABORATORY FOR BIOMATERIALS

- High Temperature Ceramic Laboratory
- Surface and Tribology Laboratory
- Biomaterial Processing and Characterization Laboratory

FOCUS AREAS

- Ultra high temperature ceramics for hypersonic vehicles
- Wetting characteristics, surface coatings, and nanomechanics of advanced structural composites
- Processing and characterization of carbon nanotube reinforced polymeric and ceramic biocomposites
- Multifunctional Biomaterials (hydroxyapatite and bioglass based bioactive materials, computational modeling, 3-D printing, hip-joint architecture)





This laboratory was initially founded as 'Laboratory for Advanced Ceramics by Late ***Prof. V S R Murthy*** in late nineties. With the change in research interests from 'ceramics for structural applications' to 'development of materials for biomedical applications', the name of the lab is changed to 'Laboratory for Biomaterials' since 2005 by ***Prof. Bikramjit Basu***. He pioneered establishing state-of-the-art research facilities to facilitate research on advanced materials processing to evaluation of cytocompatibility. The researchers from various academic institutions as well as R&D labs use these facilities. This lab took a pivotal role in leading major international multi-institutional projects in the area of Biomaterials, funded by Indo-US Science & Technology Forum (IUSSTF) and UK-India Education Research Initiative (UKIERI). The research carried out in this lab by ***Prof. Kantesh Balani*** is widely recognized by various prestigious awards, like Fellow of National Academy Of Sciences, Fellow of National Academy of Engineering, Fellow of ASM International, Yadupati Singhania Memorial Chair, Swarnajayanti Fellowship, Metallurgist of the Year, and Young Scientist awards by Indian National Science Academy/Indian National Academy of Engineering/Indian Science Congress Association among others. Under the present leadership of ***Prof. Kantesh Balani***, the researchers also focus on functional materials like ultra high temperature ceramics and surface coatings, while simultaneously pursuing research on multifunctional biomaterials.

Animal Cell Culture Facility

The facility is the hub for the in vitro culture of cells on biomaterial surface in analyzing the cytocompatibility of a material. The cytocompatibility test are performed using MTT assay (giving formation of formazan crystals upon their reaction with mitochondria of living cell) and visual inspection is also done using optical microscope and through scanning electron microscope.

Salient features

The laboratory is well equipped with high quality bio-safety cabinet, incubators, liquid nitrogen cylinder preserved with a variety of cell lines (1.929, SOS2, Hela, and hFOB), ELISA plate reader and other equipment necessary for the regular cell culture technique.

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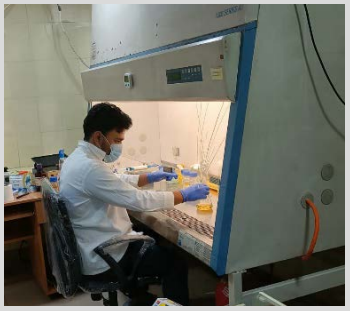
Bacterial Cell Culture Facility

This facility essentially encompasses *in vivo* study of the antibacterial properties of biomaterials. It involves a routine culture of gram positive and gram-negative bacteria on the material surface, thereby evaluating their bactericidal/bacteriostatic efficacy.



Salient features

Equipments such as bio-safety cabinet, incubators, deep freezer preserved with a variety of bacterial cell stock (gram positive- S. epidermidis, S. aureus and gram negative- E. coli), UV-Visible Spectrophotometer and other equipments required for the regular bacteria cell culture technique.

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Fluorescence Microscopy

It is a technique dedicated to identify the different cellular components, by a phenomenon of fluorescence. Fluorescence microscope is used to create an image of the cellular components stained with a fluorophore (dye).The different fluorophores used are Phalloidin, Hoechst, Mito Tracker Red for viewing organelles/components such as actin cytoskeleton, nucleus, and mitochondria, respectively.

Salient features

- Digital Camera and Eye-piece
- UV shield, Lens, Sample Stage
- X-Y Movement of the Sample Stage
- Halogen and Mercury Vapor Lamp
- Data Controller

Application

- To view tissue and their sub-microscopic components
- To study bacteria and pathogens and changes there-in
- Protein-protein and protein-cell interaction study
- Movement of virus on a bi-layered membrane

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Note: Both cell- and bacteria-culture facility were initially established by Prof. Bikramjit Basu and later augmented with Fluorescent microscope with contribution from Dr. Vivek Verma and Kantesh Balani.

Electrospinning

Model : Super ES-2

Electro-spinning uses an electrical charge to draw very fine micro or Nano fibers from a polymer in a liquid solution or melt

Salient features

- Spinning Arrangement : Horizontal, Vertical, Ultra Compact, Under Liquid Spinning
- Syringe Pump : Capacity to hold syringes from 10 µl to 10 ml, Computer Control, Stepper motor as actuator
- Spinning Chamber : Humidity display and control.(Computer Control), Temperature display and control.(Computer Control)

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Potentiostat

Model: K-lyte

An electronic instrument that measures and controls the voltage difference between a working electrode and a reference electrode. It measures the current flow between the working and counter electrodes.

Salient features

- Reference electrode: calomel electrode
- Counter electrode: Platinum wire

Application

- Corrosion studies of various metal and alloys
- Electrodeposition of metals
- Electrophoresis of bioglass

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Centrifuge

Model: Multispin Centrifuge- TC 650D

It is a simple device used to separate liquid of different densities by rotating them at high speed.

Salient features

- Tube size: 15 ml
- Maximum capacity: 120 ml
- Timer: 1-60 min
- Max. speed: 5500 RPM
- Control: Microprocessor

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High Temperature Furnace

Model : Okay

Conventional sintering unit for processing of green ceramic powders/pellets.

Salient features

- Maximum Temperature: 1500 °C
- Heating rate: 2-30 °C/min
- Environment: Air

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Surface and Tribology Laboratory

Bio Tribometer

Model: DUCOM Material Characterization Systems Bio-Tribometer(Automated)

The BioTribometer can generate cross shear motions along with loading profiles and a sliding speed in relation to the gait cycles, as per ISO 14242-1 and ASTM F732. The tribocorrosion module allows users to determine the polarization resistance, corrosion rate (mm/year), corrosion current, corrosion potential according to the ASTM G59 and ASTM G102.

Salient features

- Number of stations : 6
- Load : 20 N(min), 400 N(max)
- Frictional force : 0 N(min), 400 N(max)
- Pin - diameter x height : 3 x 15 mm^2
- Ball - diameter : 6 mm

Application

Friction and wear behavior of different biomaterials. Determine mass loss due to corrosion by using tribocorrosion setup. Lubrication behavior of bovine calf serum, fetal calf serum, synovial fluid, saliva, albumin, mucins, and other biomolecules.

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Fretting Wear Tester

Model: DUCOM Tr281 M

Salient features

- Frictional force sensor
- Frequency 1-10 Hz
- Load up to 10 N
- Friction and wear in dry / lubricating conditions

Fretting is the type of wear that occurs under condition of oscillating movement of small amplitude (1-100 mm) between two contacting surfaces.

Application

Wear resistance of implants, biological tissue, mass storage devices like coating on magnetic disks, disk substrates, contact lenses, eye glass lenses and protective coatings on CDs etc can be performed.

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Note: *The Fretting tribometer was established by Prof. Bikramjit Basu.*

Pin on disc Tribometer

Model: NANOVEA T3 400

Tribology comprises of wear, lubrication and friction among mating. Pin on disc is utilized to investigate the wear properties for certain meter length.

Salient features

- White light depth sensor
- Speed from 0.1 to 2000 rpm and load up to 50 N
- Provides three lubrication modes:
  - Low pressure pulverization module
  - Drop by drop lubrication with flow control
  - Soak option friction and wear tests

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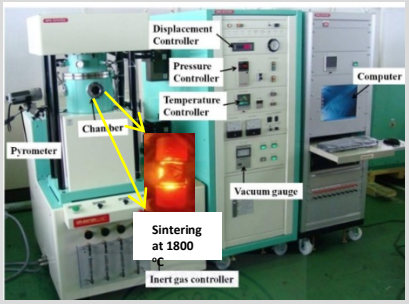
High Temperature Ceramic Lab

Spark Plasma Sintering

Model: Dr. SINTER LAB, JAPAN



Spark Plasma Sintering (SPS) is one of the variants of the Field Activated Sintering Technique, which involves the imposition of an electrical field during sintering. A large current (up to 1.5 kA) is made to flow through a porous powder compact to get really 100% dense sintered pellet.

Salient features

- Maximum temperature 2000 °C
- Load range 3.2-50 kN
- Atmosphere : Vacuum/Argon atmosphere

Application

- Capable to produce nanostructured ceramics
- Processing of ultra high temperature ceramics

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Note: *The Spark Plasma Sintering was procured by Prof. Bikramjit Basu and later managed by other colleagues.*

Thermal Analyzer

Model: STA6000 Perkin Elmer

Determines sample mass change (thermo gravimetric analysis, TGA) and heat flow change in differential thermal analysis (DTA) mode or differential scanning calorimetry (DSC) mode.

Salient features

- Temperature range of 15 °C to 1000 °C
- Heating rate Ambient to 1000°C 0.1 to 100 °C/min
- Temp. accuracy < ±0.5 °C
- Environment N_2 and O_2

Application

DSC measures the amount of energy absorbed or released by a sample, whereas TGA measures the change in weight of a sample by as it is heated, cooled or held at constant temperature.

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Tubular Furnace

Model: N.R Enterprise (INDIA)

A horizontal tubular furnace is an electric thermal processing solution with a characteristic heating chamber comprised of a continuous piece of high-temperature insulation, or two semi-cylindrical elements.

Salient features

- Maximum temperature: 1600 °C
- Heating rate:
  - 6-8 °C/min up to 1000 °C
  - not exceeding 5 °C/min for 1000-1200 °C
- Working atmosphere: helium, argon etc can be used depending upon availability
- Temperature controller: DIGITAL PID CONTROLLER

Application

- Suitable fittings are provided for- gas inlet/outlet etc with various couplings and clamps
- Typical applications of tube furnaces include the purification, coating, drying, hardening or ageing of samples

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Contact Angle Goniometer

Model : DATAPhysics OCA 15EC

Contact angle can be measured using a camera or can be analyzed through more sophisticated optical contact angle goniometer that utilizes various models and takes care of the curvature and self-sagging effects of liquid droplet to measure surface energy.

Salient features

- Dosing volume up to 2 µl to 5 µl
- Advancing and receding contact angle measurement
- Dynamic contact angle measurement can also be done
- Possible to use various fluids

Application

Wettability behavior of synthesized materials, natural objects, their surface chemistry, surface energy and surface tension.

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Compression Molding

Model: SCM-30 SANTEC GROUP

Utilized for processing of bulk polymeric samples by application of pressures at high temperatures for curing and consolidation of polymer powder into a dense compact.

Salient features

- Maximum temperature 250 °C
- Heating platen size 300x300 (mm^2)
- Maximum pressure 200 (kg/cm^2)

Application

- Bulk processing of polymers
- Preparation of polymeric sheets and pellets.

Note: *Both the Spark Plasma Sintering and Compression Molding facility were procured by Prof. Bikramjit Basu and later managed by other colleagues.*

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Raj Babu

Freeze Dryer

Model: SZ LAB INSTRUMENT

Freeze dryer is a device used to remove moisture from a sample via sublimation, or the process of turning solid ice into a gaseous vapour. This freeze-drying process is done in the presence of a vacuum and low temperature (around -80 °C).

Salient features

- Temp. Range: (-85 to -55) °C
- Display Resolution: 0.1 °C
- Vacuum Pump: 0.001 mbar
- Drying Chamber: Height (225 mm) Diameter (15 mm)

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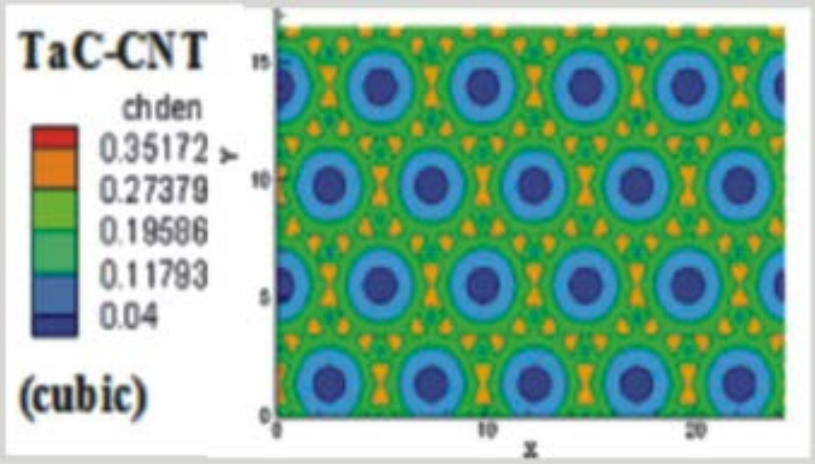
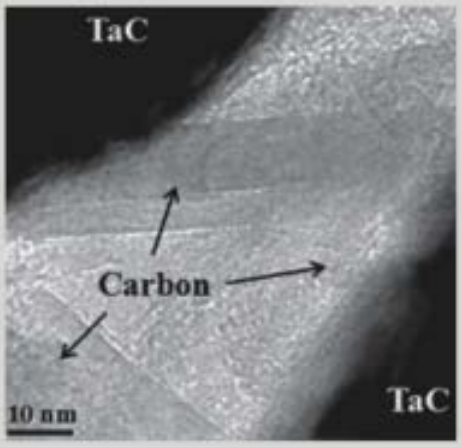
Ab-initio Computational Modelling

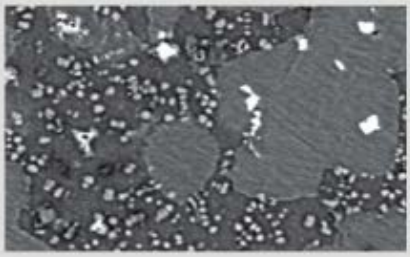
Ab-initio molecular modelling using SIESTA (Spanish initiative for electronic simulation of Thousands of Atoms) allows extracting minimum energy configurations and visualizing electronic density of an interface.



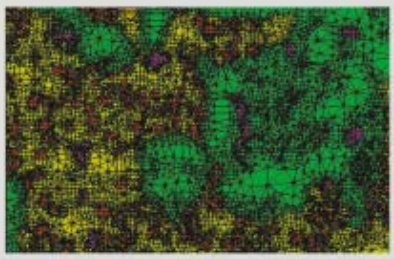


Object oriented finite element Modeling

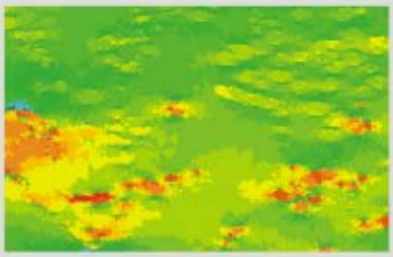
Utilizes OOF2 (Object oriented finite element modeling) software developed by NIST for evincing the stress fields, thermal conductivity, dielectric properties, etc., of the engineering materials.



SEM micrograph



Finite Element mesh



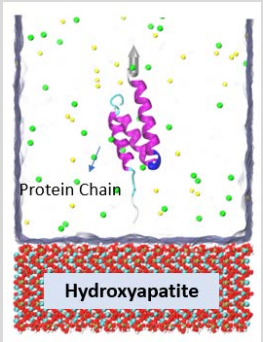
Compressive Stress Contour

Application

The equilibrated molecular structure, lattice parameters, dielectric nature can be evaluated merely from electronic structure(using ab-initio molecular modeling), whereas thermal, mechanical, dielectric, etc. properties can be evaluated using finite element modeling(FEM).

Molecular Dynamics Simulation

Understanding the interaction of proteins with different biomaterials through Atomistic Molecular Dynamics Simulations with NAMD software package developed by University of Illinois at Urbana-Champaign.



Application

Understanding the interaction of bacterial adhesin at atomic level can help us make better biomaterials.

CONTACTS
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Miscellaneous

Digital Low Speed Diamond Saw

Model: MTI Corporation, SYJ-150

- Low Speed Saw is used for sectioning hard and brittle materials
- Micrometer slide for cross-feed adjustment
- Built-in coolant tray
- Down-feed facility with different weights
- Continuously variable speed ranges from -40 to 400 rpm

Oven 1 UPTO 250°C

Model: Lalco Scientific Instruments

- Stainless steel interior and adjustable chrome-plated wire shelf
- Digital temperature display
- Chamber size 18”x 18”x18”
- Digital Precision temperature controller with +/- 1°C tolerance
- Temperature range from room temperature to 250°C

Ultrasonicator

- Power min: 100W(or higher)
- Output frequency: min 30kHz(or higher)
- Different sizes of probes
- Suitable flow shell made of stainless steel

Sieving Machine

Model: Retsch AS 200 digit

- Measuring range*: 20 µm - 25 mm
- Sieving motion: throwing motion with angular momentum
- Amplitude: digital, 0.2 - 3.0 mm
- Suitable sieve diameters: 100 mm / 200 mm / 203 mm (8")

Weighing Machine

Model: Sartorius- CPA225D

- Capacity x Readability
- 0-40g x 0.01mg
- 40-100 x 0.01mg
- 100-220g x 0.1mg
- Response Time (avg) : 6 / 3 seconds
- Repeatability : ± 0.02 / 0.05 / 0.1 mg(std deviation)
- Display : LCD - NO backlit

Gold Sputter Coating Unit

Model: VT Corporation

- Sputtered metal coatings offer Reduced microscope beam damage
- Increased thermal conduction.
- Improved secondary electron emission
- Reduced beam penetration with improved edge resolution.
- Protects beam sensitive specimens

Ball Mill

Model: MTI corporation, SYJ-150

- FRITSCH, Premium line
- Faster, simpler, and effective
- Achieves ultra fine Grinding
- High-speed milling (1100 rpm)
- Revolutionary acceleration: 95g

Polishing Machine

Model: Buehler, 137-N1685

- To get mirror polish metallographic sample
- Abrasive size 0.5um, 0.3um alumina slurry
- For final touch polished on Cloth

Hydraulic Press

Model: Polyhydron

- Used for making green pellets
- Pressure capacity 100 tones
- Hydraulic press with positive displacement pump

pH Meter

Model: LMPH-10

- Type Of Ph Meter : Benchtop
- Calibration: 3 point
- Display Type: LCD (135x 75 mm)
- Accuracy: ± 0.01 pH

0ven 2 upto 200°C

Model: MTI Corporation, SS-00AB

- Digital temperature display.
- Chamber size 280 x 280 x 280 mm (22 Liters)
- Digital Precision temperature controller with +/- 1°C tolerance
- Temperature range from room temperature to 200°C

Pyrometer

Model: HTC ™ IRX – 68 InfraRed Thermometer

- Built in laser circle with 13 laser spots increase the target accuracy
- Adjustable emissivity: 0.1 ~ 1.0
- SD card to store data, Format: CSV
- Records IR and TK data transfer to PC in real time by USB
- MAX, MIN, DIF, AVG temperature display

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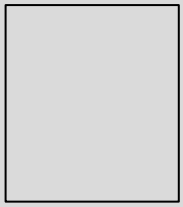

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