Facilities, Equipment and Other Resources

Kleberg Advanced Microscopy Center: Ultra high resolution TEM/STEM instrument, JEOL ARM 200F, with probe aberration correction point-to-point resolution of 0.8 Å, including EELS, EDS and electron holography and high resolution 2kx2K CCD cameras. Stages for in situ experiments: Heating stage and cryo-stage for observation at liquid-nitrogen temperature, holders for mechanics-optics-electric-magnetic measurements in situ TEM. Sample holder for electron tomography and software for 3D reconstruction and visualization. A field emission TEM-JEOL 2010F equipped with a CMOS Camera 4kx4K for quantitative analysis and a TEM JEOL-1230. A precession electron diffraction unit for the ARM200F and 2010F microscopes. SEM- STEM Microscope Hitachi S-5500 with a resolution of 4Å in both modes, a SEM Hitachi 1510 variable pressure for non-conductive samples. SPM microscopes Multimode and INNOVA Veeco equipped with atomic force mode, tapping mode, friction mode, and magnetic force mode, Scanning probe microscope with high resolution mode. A Dual Beam system SEM and focused ion beam Zeiss CrossBeam 340 with manipulator, five gas injection system and software for 3D reconstruction. An Optical microscope ZeissAX10. Sample preparation room equipment for: metals, biological materials and nanoparticles including triple point freeze drying, Jet polisher, plasma cleaner, ion milling, high temperature furnaces, high temperature reactor, sputtering chamber, and vacuum evaporator A Horiba-Joban Raman microscope with blue and red lasers and nanotribology equipment.

Nanotechnology Laboratory: This is a 4600 ft² facility equipped with 18 cubicles with personal computers for students and researchers, 1000 ft² clean room, conference room with teleconferencing, nanofabrication and metrology tools including: spin coater, UV exposure, profiler, contact-angle measurement tool, interferometer, ellipsometer, 4-point probe, Vector Network Analyzer for testing up to 50GHz with a dedicated probe station, Atomic Force Microscope with piezoelectric testing capabilities, Film-stress measurement tool, porosimeter, metal evaporator, 2 optical microscopes, X-Ray Diffraction, Tensile Tester, FTIR, barrel plasma etcher, RIE plasma etcher, 4 chemical benches, hot-embossing press as well as voltmeters, oscilloscopes, centrifuges, microscales, furnaces signal generators and an electrostatic voltmeter.

Advanced Photonics Laboratory: this is a 1,200 ft² facility that houses microwave test and measurement equipment including two Agilent network analyzers, 0.1-40 GHz and 0.1-20 GHz frequency range, 2-26.5 GHz microwave amplifier, split-ring resonator for dielectric properties measurements, and other microwave components. The lab also houses micro- and nanofabrication equipment, which include a fume hood, equipment for the synthesis of silicon and titanium dioxide micro-particles and for the growth of periodic particle assemblies. Optical characterization equipment includes an Oriel MIR8025 FTIR spectrometer, with a spectral range of 350 to 14,000 cm⁻¹, coupled to a Nikon TE200 optical microscope.

Interface Engineered Multifunctional Thin Film Laboratory: a 1,900 ft² facility that is equipped with two-pulsed laser deposition chambers with one Physik 305i Excimer laser, one Quantum Design Physical Property Measurement System (PPMS-9), and one dc/rf sputtering system. A Solartron 1260 Frequency Response Analyzer, Radiant 6000RT physical properties measurements and facilities located in our TcSUH at UH, such as SQUID, RBS-ion channeling, x-ray diffraction, transmission electron microscopy, scanning electron microscopy.

Laser Laboratory: Photon Technology International(PTI) single photon counting spectrofluorimeter with excitation, emission, decay (time resolved) from 170-5500nm,quantum yield setup with integrating sphere, Pulsed N₂ pumped due laser,800 and 980nm laser diodes(power range 100mw to 3W), colorimetry setup, light source irradiance setup with tektronics light meter, optical cell imaging system with visible and NIR camera, Ti:Sapphire with Nd:YVO₄ Pump laser, Argon ion laser, Q-switched Nd:YAG (1.06 μm) laser, Nitrogen Laser-pumped tunable dye laser, He-Ne lasers (4), Eight NIR diode
lasers (1.0 – 4.0 μm), UV, VIS, (Photomultiplier Tubes, Photodiodes) and IR detectors (Ge detectors), Closed-cycle He cryogenic refrigerator, Optical Polarizing Microscopes (1 Nikon and 1 Olympus), Oscilloscope (2), SPEX Monochromator Model 1250 M controlled by Data Scan with DAQ and GPIB, Cary-14R Spectrophotometer upgraded by OLIS, CTI Model 22 from CRYO Industries, Integrating Spheres (4)


**General Techniques**: Spectroscopic ellipsometer (Woollam), Capillary Electrophoresis (PACE/MDQ Beckman Coulter) with UV detection, High voltage power supply (for microchip applications)(2), CHI812 potentiostat with PC and software, Inspection microscope with digital camera and software, pHmeter (Orion), Analytical balance (Metler-Toledo), 2 6-feet hoods & 2 4-feet hoods, General laboratory instrumentation (pipettes, ovens, UV-Vis spec, etc), 4 additional computers (with Internet connection) are also available for data analysis.

MALDI-TOF (Bruker REFLEX III), HPLC (SpectraSystems), MS (Finnigan LCQ Duo, Finnigan TSQ 700, Fissons VG PlasmaQuad), GC/MS (Finnigan PolarisQ), NMR (Varian INOVA 500 MHz, Varian 300 MHz), FTIR (Bruker Equinox 55 FTIR), EPR (Bruker X-Band EMX 6/1-HX), X-Ray Diffractometer.

**Multifunctional Electronic Materials and Devices Research Lab (MeMDRL)**: The newly established Multifunctional Electronic Materials and Devices Research Lab (MeMDRL), is a 3,000 sq.ft laboratory hosted in the Bio Science Engineering Building, UTSA. It will support the proposed project for materials processing, property evaluation, and numerical simulation at UTSA. Specialized equipment established in MeMDRL includes:

- **Crystallographic and Micro-Structure Characterization Capabilities**:
  - Powder X-ray Diffractometer, Shimadzu LabX XRD-6000, with PDF2 and JADE Plus.
  - Single crystal X-ray diffractometer DX-100.
  - A scanning electron acoustic microscope (SEAM) having both microscopic resolution and non-destructive bulk property imaging capability.
  - A research polarizing optic microscope with both heating and cooling stages that cover temperature range from -170°C to +1500°C, with or without application of electric field.
  - A Veeco Multi-Mode V Scanning Probe Microscope/Atomic Force Microscope/Piezo Force Microscope with variable temperature capability (-35°C to +250°C) and compatibility of electrochemical and magnetic measurements.

- **Materials Synthesis Capabilities**:
  - Powder preparation (chemical hoods), milling (planetarium mill), pressing (hydraulic 100T press), calcining and sintering (atmosphere controlled furnaces to +1800°C)
  - Sample preparation and metallization (plasma sputter). Single crystal orientation. Ultrasonic cleaning, polishing, dicing, and cutting (disc and precision diamond wire saws).
  - Sol-Gel laboratory with environmental glove box, spin coater, film profilometer, and rapid thermal annealing furnace.

- **Crystal Growth Capabilities**:
- A state-of-the-art Laser Heated Pedestal Growth (LHPG) station growing single crystal fibers 100 \( \text{m} \) in diameter and several inches in length
- An Optical Image Furnace (OIF) permitting single crystal growth in controlled atmosphere or under pressure.

### Dielectric and Ferroelectric Property Measurement Capabilities:
- Lakeshore Cryogenic station with microprocessor controlled and computer interfaced 10K-500K temperature system.
- Dielectric, piezoelectric, pyroelectric and electromagnetic characterization facilities in broad frequency range (0.1Hz to 1MHz, RF-20GHz) and temperature (10K to 500K) range. Major measurement components include: network analyzer HP 8753E, LCR meter HP4284A, RF impedance analyzer HP4291A, HP Impedance/Phase Gain Analyzer 4194A, HP 4140A pA meter, power supply, amplifier and controller Trek 610D, Stanford Research Lock-in Amplifier SR830 and SR844.
- Polarization and field induced strain measurement: modified Sawyer-Tower polarization and strain measurement station as function of applied electric field and temperature, Radiant RT66 system, and ZJ-4B \( d_{33} \) meter.
- Microwave measurement capabilities including post resonant and perturbation waveguide measurement configurations, probe stations, spectrum analyzer (Anritsu 2667C 9kHz to 30GHz)
- Environmental test chamber (ESPEC) \( -80^\circ \text{C} \) to \( 180^\circ \text{C} \) microprocessor controlled and computer interfaced, for device test and property evaluations.

### Strain measurement facilities
- Thermal expansion: A high precision double rod differential dilatometer with temperature range \(-165^\circ \text{C} \) to \(+650^\circ \text{C} \).
- Optical single beam ultra-dilatometer with high displacement detection resolution (~0.1 nm) and sensitivity (better than \( 10^{-3} \) nm) on electric field induced strains.
- Optical fiber sensor coupled with cryogenic temperature stage capable of measuring strains in temperature 10K-300K, with displacement detection resolution ~1 nm.

### Optical Engineering Capabilities:
- Indices of refraction measurement in bulk materials (minimum deviation method) in visible and near IR frequencies (room temperature to 600\(^\circ\)C) and in films (micro focused ellipsometer) at 633 nm.
- Linear and quadratic electrooptic coefficient measurement (Senarmont compensation and modified Mach-Zehnder method)
- High sensitivity Chynoweth dynamic pyroelectric and pyrooptic measurement system.
- He-Ne lasers, laser diodes and IR fiber lasers, high power CO\(_2\) (Edinburgh and Apollo) flowing gas laser, Nd:YAG laser (Spectra-Physics Quanta Ray with phase lock and Quatronix with Q-switch) with SHG and THG output, and dye lasers (Sirah Precision Scan) with pulsed and CW laser output.
- Optic/Microwave probe station equipped with micro-movement control, CCD camera and TV display, and adapted with micro-tweezers capable of precision handling of micron-sized samples and thin film samples.
- Optical spectrum Analyzer (Advantest Q8381A 350 nm- 1750 nm).
Computation capabilities: computers and workstations on site and with access to CBI nodes. Software site licensed: COMSOL (multiphysics including RF and acoustic modules), FEM LAB, MAT Lab, ATILA, LAB View, and Mathematica etc.

RCMI Biophotonics Core
The RCMI Biophotonics Core provides cutting edge technology for the study and manipulation of biological samples using light. Our Zeiss 510 confocal is equipped with 7 lasers lines, a wide range of high quality objectives, and 3 PMTs, including a Meta detector, which allows the collection of up to 16 channels regardless of spectral overlap. Our newest instrument, the Zeiss 710 Live Cell Imaging System is both a fully equipped confocal and multi-photon system. It is complete with oxygen and temperature control for environmental control. A Ti:Sa laser, the Chameleon Ultra II by Spectral Physics, permits long-term in-depth imaging of live tissues. These instruments allow our core users to probe from the population and cellular to the molecular level within live intact tissues. To ensure that the full potential of core technology is realized, the Biophotonics Core provides personal training in the use of all instrumentation, as well as in the latest methods of data analysis using the most current versions of Imaris, widely considered to be the state-of-the-art 3D image processing and analysis tools available. Our core currently supports over 30 users across the colleges of science and engineering.

Advanced Computation
Wide screen plasma for visualization, Microway Xeon + Tesla GPU OctoPuter server (with 4 Tesla C2070, each one with 448 processors and 6 Gb of RAM memory, 12 CPUs Intel Xeon X5670 Westmere 2.93 GHz Six with 48 GB RAm memory, peak performance of 515 GFLOPS), APC UPS SUA3000RM2U - 120V - 2700W, 4 Microway Six-Core Xeon WhisperStation (eatch one with Intel Xeon W3680 Nehalem 3.33 GHz Six Core CPU, 6 GB RAM memory and 1 TB Seagate Constellation hard drive), Optical Fiber connection between server and workstations. Two Dell PowerEdge Rack Servers, six Dell Precision Workstations with NVIDIA GPUs (two 5000K, three 5800, one 3700, and one Tesla 1070). 10 Hz optical parametric oscillator laser (EKSPLA NT342B) with wavelength range 400-2600 nm, spectrometer (Horiba Jobin Yvon iHR320) computer controlled equipped with xenon lamp, liquid cooled-PMT, PMT capable absorption, transmission, reflection and fluorescence experiments, Dynamic Light Scattering system (Malvern Zetasizer Nano ZS) capable of size, zeta potential and molecular weight analysis, Microscopes with CCD (Leica, Olympus), Diode Lasers, oscilloscope, mini-spectrometer, vacuum oven, furnace, UV oven, and centrifuges.

The computational nanotechnology laboratory is equipped with a Dell blade server cluster –Antares 3-with Opteron 6140, 8 of 6-cores each, and 42-processor systems. VASP (Vienna Ab-Initio Simulation Package) for performing ab initio quantum mechanical molecular dynamics. Density-Functional-Theory-Based codes available in SIESTA, Abinit and Octopus. Xcrysden, GDOS, VMD, Gace, R, VLC, DMol, Adobe Acrobat 3D and CrystalMaker. Apple Mac Pro 8-core, two 2.26GHz Quad-Core Intel Xeon “Nehalem”, 6GB memory, 640GB hard drive, NVIDIA GeForce GT 120 with 512 MB and Apple iMac 21.15-inch 3.06 GHz Intel Core 2 Duo, 4GB memory, 1TB hard drive, ATI Radeon HD 4670 graphics with 256MB.