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# Advanced Materials Engineering Research Institute (AMERI) and Motorola Nanofabrication Research Facility

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## Abstract
The College of Engineering at Florida International University has established the Advanced Materials and Engineering Research Institute (AMERI) to provide an open access equipment infrastructure to support materials research and engineering over a broad range of technology and capabilities. The Institute provides analytical instrumentation, materials characterization, and process development laboratories to support faculty and industry in the development and characterization of new materials over the continuum from the nanoscale to bulk materials. The Institute contains the Motorola Nanofabrication Research Laboratory, allowing for fabrication of nano/micro electromechanical systems (N/MENS). The Analytical Instrumentation Laboratory contains multiple scanning electron microscopes, transmission electron microscopes X-ray diffractometers, and a wide range of thermal and mechanical testing capabilities, in addition to process development laboratories available to support faculty, students and industrial researchers**.**

## Keywords
Nanofabrication, materials characterization, MEMS, e-beam lithography, focused ion beam nanomachining

## 1. Introduction
The Advanced Materials and Engineering Research Institute provides an open access equipment infrastructure to support materials research and engineering over a broad range of technology and capabilities. The Institute provides analytical instrumentation, materials characterization, and process development laboratories to support faculty and industry in the development and characterization of new materials over the continuum from the nanoscale to bulk materials.

The analytical Instrumentation Laboratory contains a field emission scanning electron microscope (FESEM), a 200 KeV Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM), X-ray diffraction, thermal (DSC, TGA, DMA, dilatometer flush diffusion), and mechanical testing (uniaxial/biaxial Instron, creep). In addition, access is available to the Environmental SEM and electron microprobe available in the Florida Center for Analytical Electron Microscopy (FCAEM) at FIU. Process Development laboratories for ceramic processing (sol-gel, tape casting, milling), thermal processing (air, vacuum, hydrogen, controlled atmosphere furnaces) are available to support faculty and industrial researchers.

The Institute contains the Motorola Nanofabrication Research Facility, which is supported by a class 100 clean room and nanofabrication capabilities including e-beam lithography, optical photolithography and focused ion beam nanomilling. This facility was initiated by the donation from Motorola of a complete MEMS laboratory, and expanded by FIU into nanofabrication by addition of high resolution e-beam and FIB processing. Fabrication of nano/micro electromechanical systems (N/MENS) can be accomplished by a combination of nanolithography, reactive ion etching, and thin film deposition by a variety of techniques (e-beam, sputtering, filament evaporation, laser ablation and chemical vapor deposition).

Florida International University, the largest University in South Florida with 35,000 students, is ranked as a Doctoral/Research Extensive. As an urban University, the student body reflects the diversity of the region, with an engineering student body comprised of 53% Hispanic and 14% African-American. The College of Engineering graduates more Hispanic engineers than any other University in the continental US. The location of FIU, and AMERI, in the multi-cultural, transportation hub city of Miami, provides easy access to the facility for researchers from Latin America and the Caribbean.

**2. Instrumentation Capabilities within AMERI**

***Materials Characterization Laboratory***

- Electron Optic Equipment (SEM ,TEM, Microprobe)
    - *JEOL 7000* Hot filament Field Emission Scanning Electron Microscopy (FEG-SEM) (300,000 X max. magnification)
    - *JEOL 6330F* Field Emission SEM (FEG-SEM) with Energy Dissipation Spectrum (EDS) (150,000X)
    - FEI CM-200 200 kV Transmission Electron Microscope (TEM) with *Oxford* Energy Dissipation Spectrum (EDS)
    - JEOL Internet accessible microprobe and environmental SEM available in Fla. Center for Analytical Electron Microscopy (FCAEM)
- X-Ray Diffraction
    - Bruker GADD/D8 X-ray system with an Apex Smart CCD Detector and a direct-drive rotating anode as the X-ray generator (18 kW)- 50 μ spot size
    - Bruker 5000D X-ray Diffractometer with Goebel mirrors, Anton-Parr high pressure reaction cell
    - Bruker 500D X-ray Diffractometer (XRD) with 1600$^{o}$C high temperature furnace attachments.
- Thermal analysis
    - Differential Scanning Calorimeter (DSC)
    - Dynamic Mechanical Analyzer (DMA)
    - Thermogravimetric Analyzer (TGA)
    - Dual Rod Dilatometer
    - Flash diffusivity
- Optical Microscopy and Complete metallography facility with precision diamond cutting, mounting, and automatic polishing equipment

***3. The Motorola Nanofabrication Research Facility***

- JEOL 7000 hot field emission E-beam lithography system with Nabity controller
- FEI Focused Ion Beam 800 XP
- CVD furnace for CNT
- Multi-mode AFM/MFM/STM Probe System
- 350 sq. ft. class 100 clean room
- 1200 sq. ft. class 10,000 clean room
- 10 KeV four pocket e-beam deposition system with planetary and residual gas monitoring
- 4 sputtering systems, all cryopumped
- 2 Reactive Ion Etchers (one for Cl with gas cabinet, monitor and scrubbers)
- Thin film Profilometer
- Wet etching with spin washers
- 2 Isotropic plasma etchers and LPCVD
- Optical lithography (Habraline 500 contact mask aligner)
- Heidelberg direct write lithography tool
- 3 and 6" tube furnaces, vacuum, hydrogen and controlled atmosphere furnaces to 2500oC
- Complete microelectronics packaging laboratory including complete fabrication capability for LTCC technology, organic laminate technology (PCB, HDI, and flex) and thin film deposition.

**Ceramic and LTCC Processing Laboratory-**

*Materials Development-* complete thick film processing (ball mills, three roll mill, viscometers) and prototype tape casting

*Processing*: OZO high speed micro drill and router, uniaxial and isostatic laminators, vacuum bagger, screen printing with vacuum pull-down, slow ramp controlled temperature box furnaces (2), hydrogen furnace, camera furnace. Both ball and wedge bonders are available, allowing bonding of Au, Al wire and Au ribbon. Currently, a high speed micro-punch (50 μm via punch) , $CO_2$ laser tape cutter (.001 " via fabrication), Bladder via filler system are being added to the facility.

All of these facilities are open to academic researchers at a cost recovery basis, with the cost structure equivalent to FIU faculty and staff. The facility provides safety and process training to allow easy and open access for users. Examples of current research in the facility will be presented.

## Authorization and Disclaimer