Institute of Materials Research (IMR)

Marc Weber  
John S. McCloy, director

Contact: Marc Weber or Rebecca Griswold  
(509) 335-8145; m_weber@wsu.edu  
https://materialsresearch.wsu.edu

Services:
• **Diagnostics**: Xradia, Positrons, Electrical, Defect spectroscopies  
  • Missing atoms: Atomic-scale, voids-mesopores, nanometer to micron pores  
  • 3D sub µm structures  
  • Mid bandgap defects, Raman spectroscopy, FTIR, Hall
• **Crystal growth**: Czochralski, Bridgman
• **Class 1000 cleanroom**: ALD, sputtering, annealing, plasma etching
Objective

- Educate next generation engineers & scientists
- Modern/unique spectroscopic tools
- Opportunity to try ideas outside the standard process
- Establish links to broad research/industry community
- Worked with
  - Universities
  - Government national laboratories
  - Industry
    - NDAs are no problem
X-ray nanoCT microscope

• Computed tomographic images from X-rays
  - 3D absorption reconstruction
  - 5.4 kV X-ray nano-CT microscope
  - 50nm or 150nm spatial resolution up to 65 µm samples
  - Optimized for low Z low density matter

• Examples
  - Non woven fibers, graphite fibers, catalysts,
  - battery membranes
  - Shale rock (porosity)
  - Biologic materials, structural fibers

• Students/Vistors are welcome to work on their own projects

• WSU undergrads won NASA grant to study lunar dust removal

materialsresearch.wsu.edu;  (509) 335-8145;  m_weber@wsu.edu
Vacancy ID and depth profile

• Atomic to nm damage near surfaces
  - Depth profiles
  - Residual damage from cutting polishing
  - Vacancy characterization
  - Non-destructive

• Finds places in matter where atoms are missing
  - Vacancies up to 10 nm porosity
  - Isolated pores vs. interconnected pores
  - Identify impurities next to missing atoms

• Research topics
  - Metals: vacancy formation enthalpy
  - Solar cell materials: Si, CdTe, perovskites
  - Novel semiconductors: GaN, ZnO, Ga₂O₃, SiC
  - Porous thin film layers: low-k dielectrics, membranes, filters
  - Ceramics and glasses: for nuclear waste management

How? Missing atoms are detected with anti-electrons, positrons. Annihilation photons deliver information
Want to try different doping?

• Methods
  - Czochralski (pulling from melt)
  - Bridgman (vertical, high pressure)
  - Zone refining

• Examples/ Variations
  - Ruby, YAG, CdTe, Cd_{1-x}Zn_{x}Te, Ga_{2}O_{3}
  - Unique doping: Ce, Nd, Ti, Cu, Cr, Zr, Hf, In
  - Rotating crucible, w. acceleration

• Research topics
  - Ce:YAG Ce:GGG for scintillation radiation detectors
  - Cd_{1-x}Zn_{x}Te: Solar cell material, radiation detectors
  - Ga_{2}O_{3}: wide bandgap semiconductor single crystals
Growth / processing

Thin film deposition
- Atomic layer deposition
- RF/DC magnetron sputtering
- Spin coating

Electronics fabrication
- Photolithography
- Wire bonding
- Wet/Dry etching (plasma, reactive ion)

Thermal processing
- Oxidation
- Boron diffusion
- Vacuum annealing

Measurement
- Profilometry
- Ellipsometry

Cleanroom / Microfabrication

Thin film deposition
- Atomic layer deposition
- RF/DC magnetron sputtering
- Spin coating

Electronics fabrication
- Photolithography
- Wire bonding
- Wet/Dry etching (plasma, reactive ion)

Thermal processing
- Oxidation
- Boron diffusion
- Vacuum annealing

Measurement
- Profilometry
- Ellipsometry

Characterization

Electrical measurements
- Hall, I-V, C-V

Defect spectroscopy
- TEES/TSC
- DLTS/ODLTS/PICTS
- TL/TSL, PL/PLE

Detector testing
- resolution, μτ, PMTs, light output, lifetime

Standard
- Raman imaging (3 color)
- X-ray diffraction (3 energies)
- FTIR
- UV-VIS-NIR
- MMW
- IR and VIS imaging microscopes
- Lab-based X-ray absorption

https://materialsresearch.wsu.edu/
rgriswold@wsu.edu, m_weber@wsu.edu