



WPI

*Technical and scientific know how and
the equipment to get it done*

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Additive Manufacturing



VRC Gen III **Cold Spray System** - Capable of producing coatings with diverse compositions on a multitude of substrates

GEFERTEC arc405 **Wire Arc Directed Energy Deposition** (Wire Arc DED) System - Capable of printing large (330 lb.) 3D metal parts at high deposition rates controlled by a five-axis robotic system



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Powder Processing

Nabertherm High-Temperature Inert Gas
Rotary Tube Furnace

Thermotron **Environmental Chamber**

Low temperature **Box Furnaces**

MRF Bell Jar **Arc Melter Furnace**



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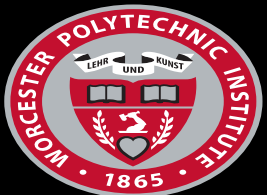
Powder Characterization

Microtrac MRB's SYNC Particle Size Analyzer

Hall Flowmeter from Alcan Powders & Pigments

Mercury Scientific's Revolution Powder Analyzer (**Powder Rheometer**)

Retsch Vibratory Sieve System



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Elemental Analysis

Eltra ELEMENTRAC ONH-p 2 Analyzer

Horiba Inductively Coupled Plasma - Optical
Emission Spectrometer (ICP-OES)

Mettler Toledo C30S Coulometric **Karl
Fischer Titrator** with an InMotion KF Pro
Oven Autosampler



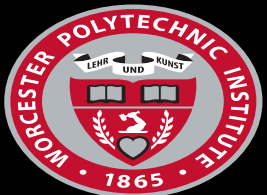
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Micromechanical Characterization

KLA Instruments NanoFlip
Nanoindentation System

KLA Instruments iMicro Pro -
Nanoindentation System

Keysight G200 Static **Nanoindenter**

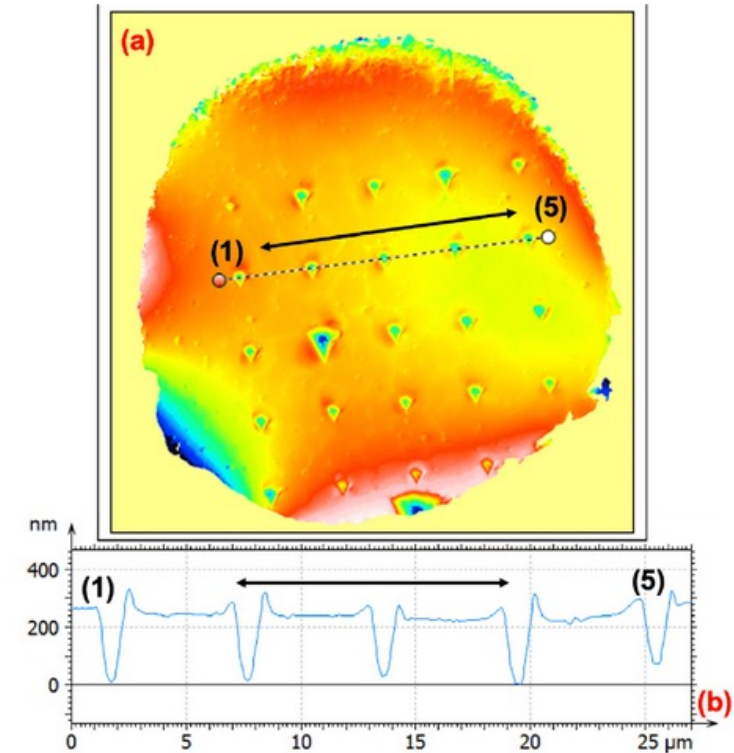


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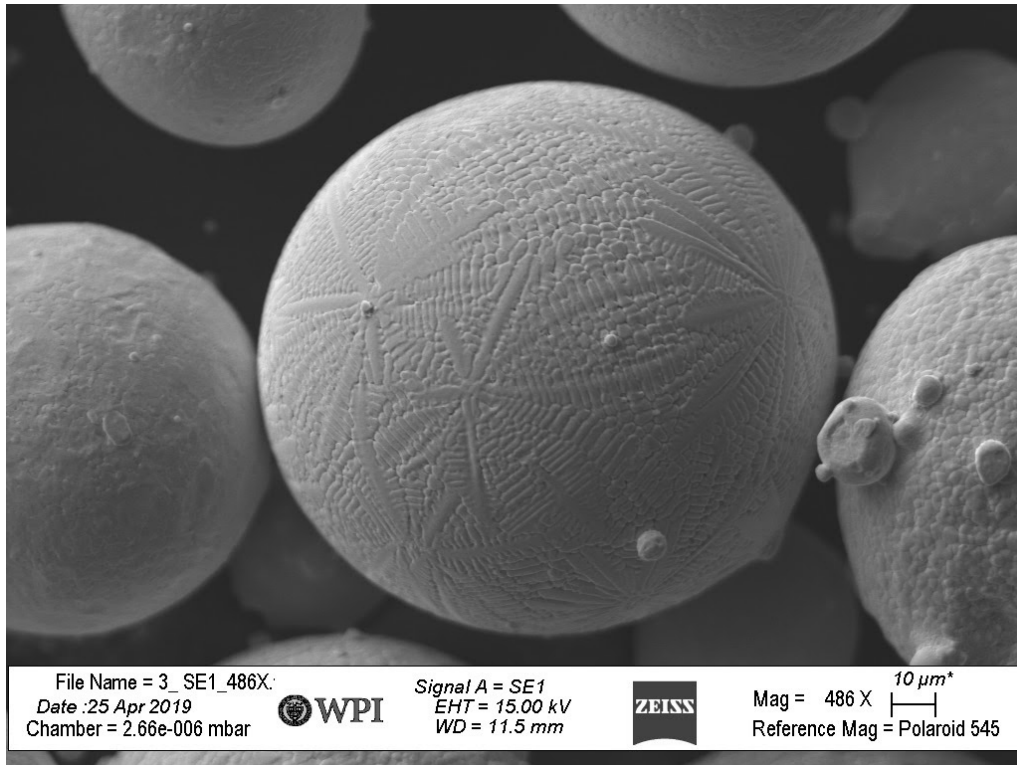
Micromechanical Characterization

Shimadzu MCT Particle Compression
System

Plasometrex (UK) Profilometry-based
Indentation Plastometer (PIP)



In-Lab Microscopy



Keyence VHX-7000 **Digital Microscope**

Olympus Corporation **Inverted Optical Microscope**

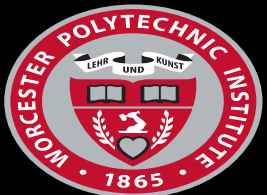


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Chemical Analysis

Foseco Alspec—H – Hydrogen
Content Analyzer

MBRAUN LABstar Glovebox



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Chemical Analysis

SpectroMAXx LMX04 Optical Emission Spectrometer – Accurate chemical analysis of metals and alloys



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Chemical Analysis

Olympus Vanta XRF – **Handheld XRF Analyzer**

8 channel **MTI Battery Potentio-Stat** – Battery Characterization

16 channel **Bio-logic VMP3 Potentio-Stat** – Melting up to 35 lbs.

16 channel **Bio-logic VMP3 Potentio-Stat** – Melting up to 50 lbs.



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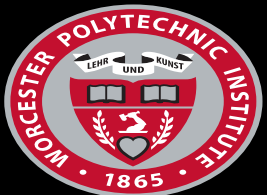
Electrode Fabrication

Carver 25-12 Press

MTIXL Electrode Coater

SCK-100 Spin Coater

ACM LAB NILL-800 Milling Machine



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High Temperature Processing

Rotating **Impeller Degasser** (Custom built) – Degassing liquid aluminum

N-Tech Metal Health Center – Fluidity & Hot Tearing Measurements

ASTM Tensile Bar Mold – Tensile Testing of Cast Alloys

Gas Tech II Reduced Pressure Tester – Melt Analyzer



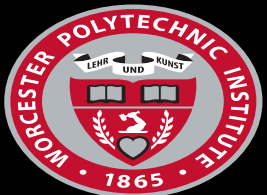
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High Temperature Processing

Barnstead Thermolyne Box Furnace 30400 – Max Temperature 982° C

Thermolyne Box Furnace 48000 – Maximum Temperature 1093° C

Mellen Microtherm 1250 Box Furnace – Maximum Temperature 1150° C



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High Temperature Processing

**Baker Model 6 – Max Temperature 1000° C,
Programmable Box Furnace**

SentroTech Furnace ST-1600C-445

**Schutte-Buffalo W-6-H Hammermill –
Shredding Machine**



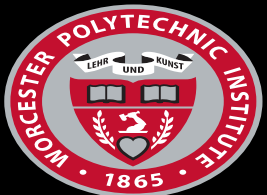
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Thermal Analysis

Simultaneous Thermal Analyzer (Combined Thermogravimetry and Calorimetry) Netzsch STA 449 F3 Corrosive Version

- *Small furnace combined with a highly sensitive balance*
- *Corrosive Version – Reactive atmospheres like C₂H₂, CO, NH₃.*
- *In-situ monitoring of mass changes (thermogravimetry) and release/consumption of energy (calorimetry). Temperature range RT to 1600°C; cooling/heating rate up to 50°C/min.*

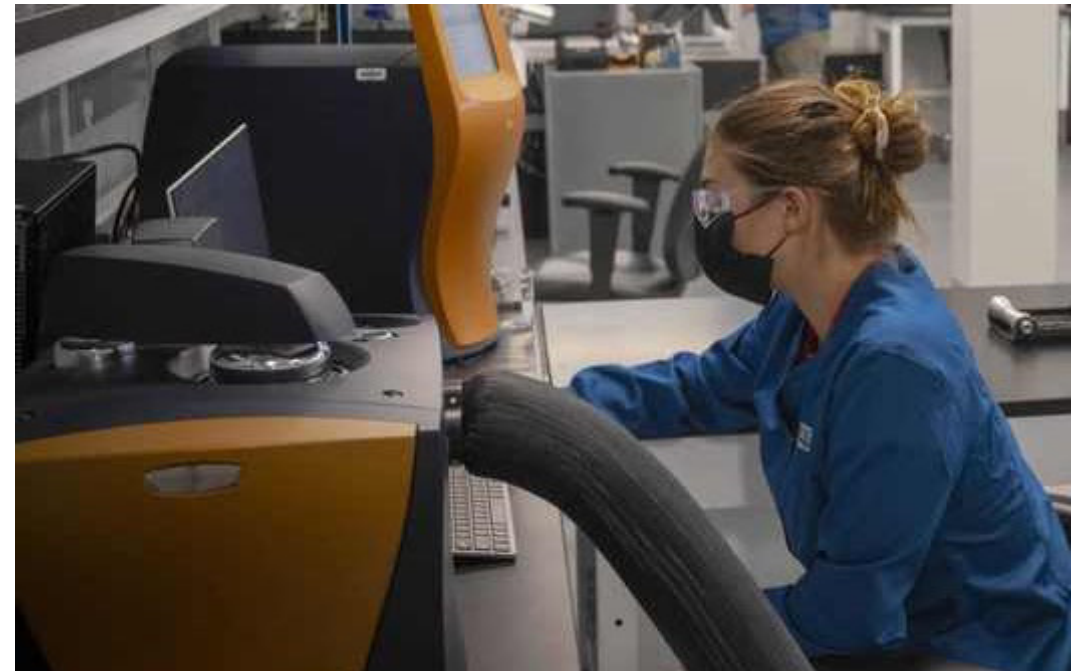
Versatile instrument for in-situ nitriding, carburizing, oxidizing, etc.
Calorimetry is especially well suited for detecting phase transformation.



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Thermal Analysis

TA Instruments Differential Scanning Calorimeter (**DSC**)



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Electron Microscopy



Thermo Scientific Scios 2 DualBeam – Focused Ion Beam Scanning (**FIB-SEM**) Equipped ETD, in-lens trinity detection system, Ivd, ICE detector, retractable DBS detector, retractable STEM detector, Oxford Instruments Ultim Max 100 mm² EDS and Symmetry 2 EBSD system

EMS 150R Sputter Coater – SEM Sample Prep



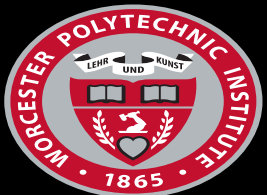
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Electron Microscopy

JEOL 7000F LF **Scanning Electron Microscope**
with DEBEN-BSED-GEN5 backscatter detector,
Oxford Aztec EDS and EBSD system

JEOL 100 CXII – Transmission Electron Microscope
(TEM)

JEOL 100 CXII Transmission Electron Microscope
Equipped with **Gatan Orius 830 CCD Camera**



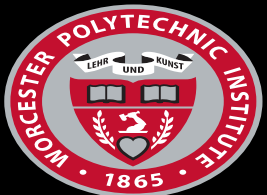
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Electron Microscopy

**Zeiss EVO-MA10 Scanning Electron
Microscope (SEM)**

**Energy-dispersive X-ray Spectroscopy
(EDS)**

**JEOL Argon Ion Beam Cross Section
Polisher**

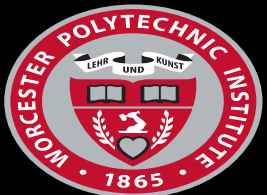


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In Lab Microscopy

Nikon **Epiphot 200** Optical Microscope

Nikon **Stereo** Microscope



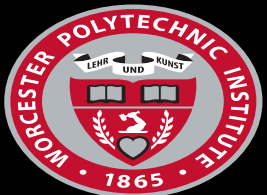
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X-Ray Diffraction

PANalytical Empyrean X-ray Diffractometer - Powder Diffraction, Stress Analysis, Texture Analysis, X-Ray Reflectivity Analysis, & Small-Angle X-Ray Scattering.

Bruker AXS Kappa Apex II single Crystal X-Ray Diffractometer

Bruker AXS D8 FOCUS X-ray Diffractometer



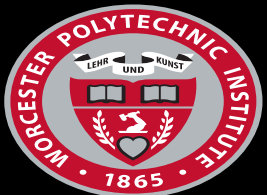
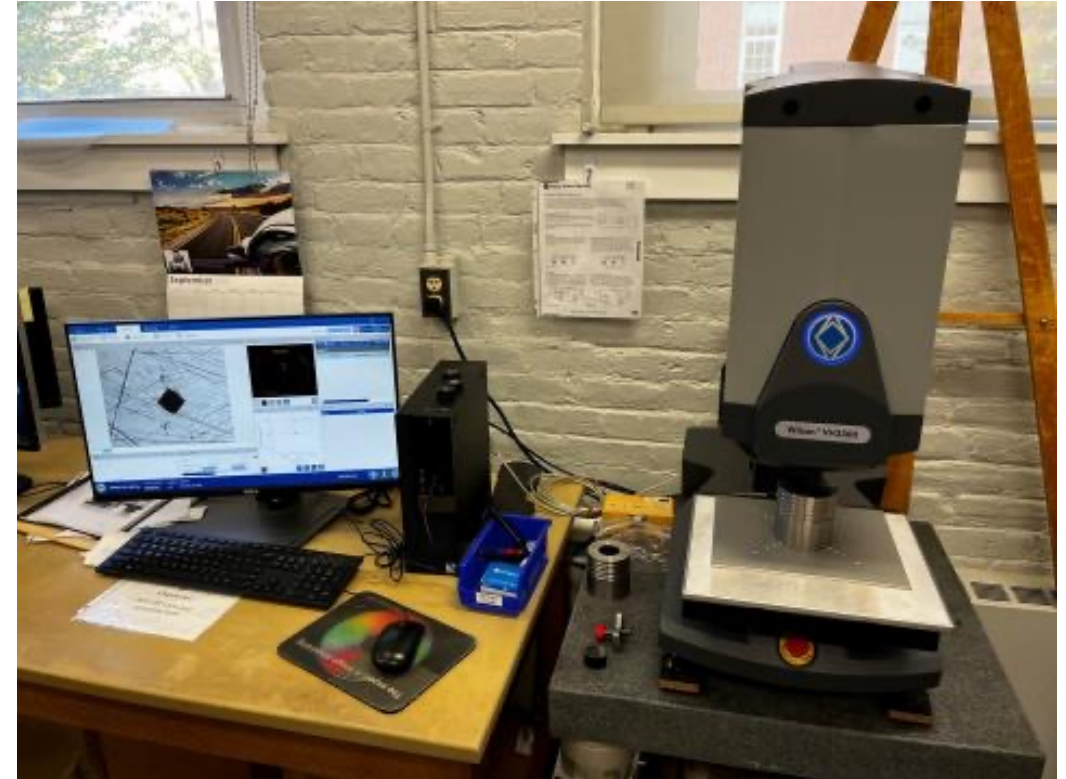
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Mechanical Characterization

VJ Technologies Value CT Scanner

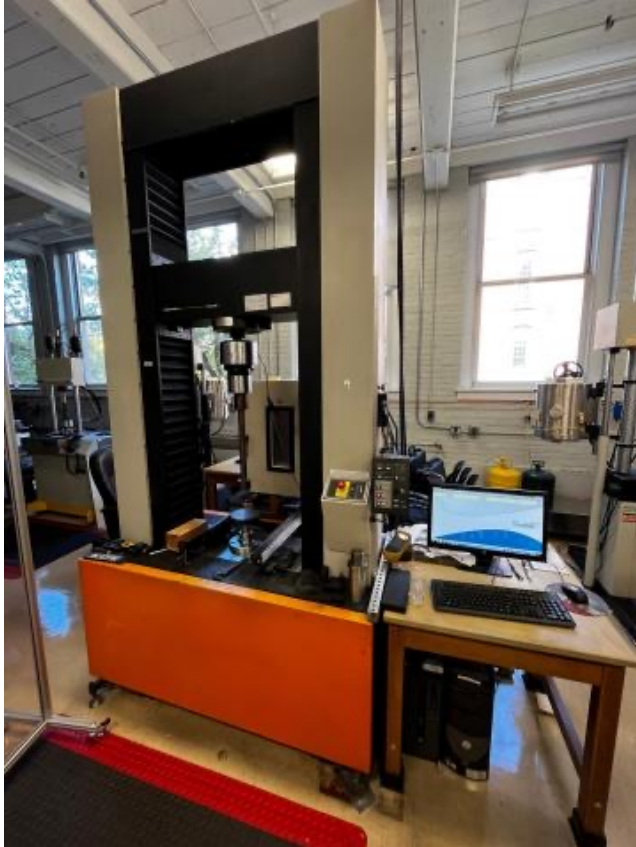
Instron Charpy Impact Tester

Wilson VH3300 Vickers-Knoop Hardness Tester



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Mechanical Characterization



Keysight/MTS Nanoindenter

Instron 5500 Tensile and Compression Testing Machine



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Metallographic Preparation



Buehler **IsoMet High Speed Pro** Precision Saw

Buehler **IsoMet 1000** Precision Saw

Buehler SimpliMet 4000 Mounting Press

Buehler EcoMet 250 Pro – **Polisher/Grinder**

Buehler **VibroMet 2** Vibratory Polisher



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Metallographic Preparation

Techne-52 Fluidized Bath

Allied Diamond **Wafering Saw**

Pace Technologies NANO 2000T – **Manual Polisher**

Extec LabCut 300 **Abrasive Saws**

Struers Tegramin 20 – Polisher/Grinder



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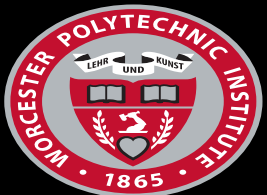
Manufacturing

ST-10 Lathes with Tailstocks



ST-30 Bar Feeder

Accutex GE-43SA Wire EDM



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Manufacturing

Accutex **Sinker EDM**



CNC Horizontal & Vertical
Bandsaws

60W & 150W **Laser Cutters**



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Manufacturing

Robots 2x UR-5*, 1x ABB

**Weld Shop with 2x MIG welders, 1x
TIG/combination welder, plasma cutter, 2x oxy-
acetylene torch, cutoff saw and other equipment**



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Future Laboratory Resources

20L Non-Jacketed Reactor Kit

TSO 111060-23-SN Single Zone Rotary/Reactor Tube Furnace

Instron 68FM-300 Electromechanical Floor Model Testing System

Sentro Tech ST-1700C High Temperature Box Furnace



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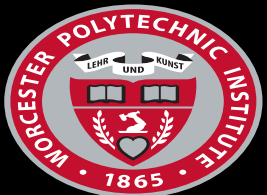
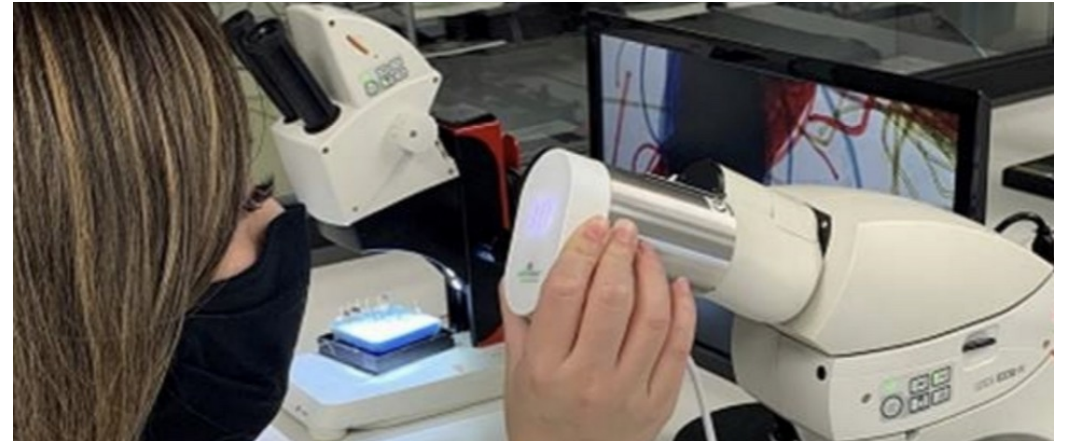
Future Laboratory Resources

400 mm Filter Trolley Sambo Creeck BABF

Buhler **Mini-Arc Melting System** MAM-1 with
Generator w. High Frequency Ignition,
Vacuum Set and eChilly

Keyence VHX-700N **Digital Microscope**

Gamry **Potentiostat/Galvanostat/ZRA** with
EIS



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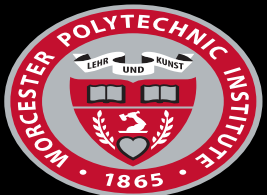
Future Laboratory Resources

EMS/Q150V ES Combined Sputtering and Carbon Coating System – for high vacuum applications

Leica M205 C Stereo Microscope

Chemglass High Pressure Custom Leaching & Precipitation Reactor System

Surface Coater



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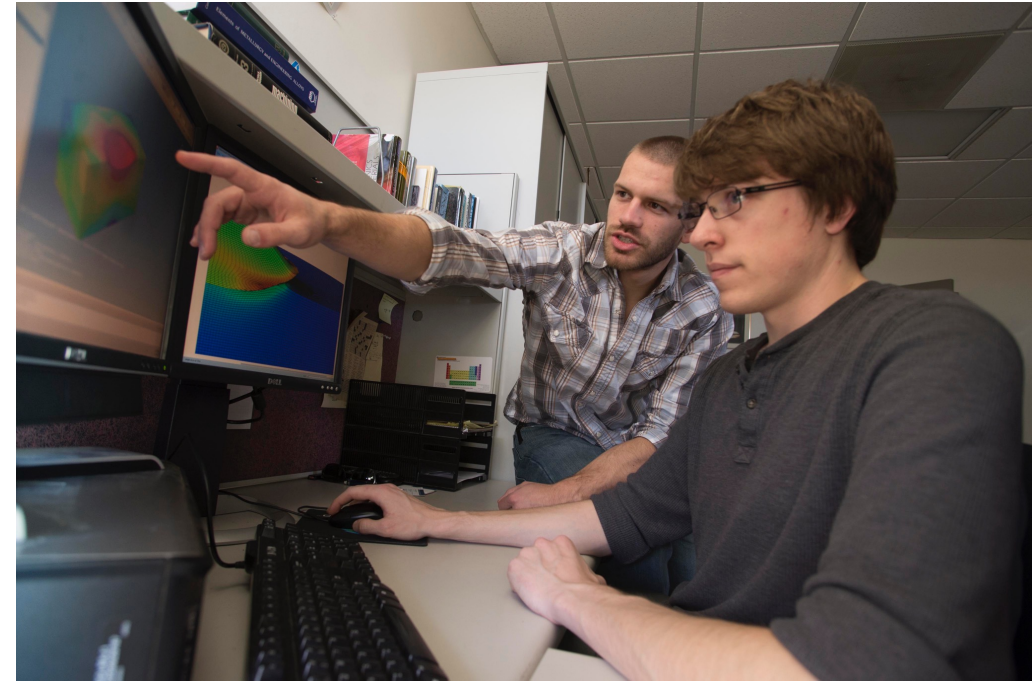
Future Laboratory Resources

Arc Melter

Pelletizer

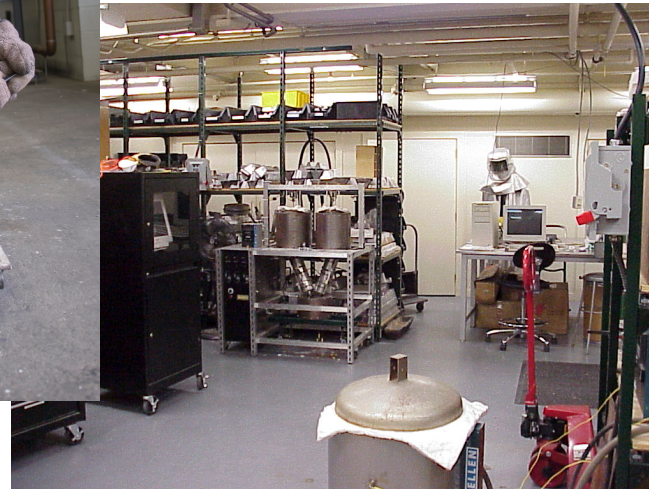
L.C. Miller Induction Heating System

FCA 4590 HP/HT Reactor System



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Thank You!



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