UNT’s Materials Research Facility (MRF)

University of North Texas
E-178 Discovery Park
3940 North Elm Street
Denton, TX 76207

https://mrf.research.unt.edu

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For more information about MRF equipment, contact David Jaeger at 940-369-8106 or David.Jaeger@unt.edu
• The Materials Research Facility (MRF), formerly known as the Center for Advanced Research and Technology (CART) was established at the University of North Texas (UNT) in 2004 through support from the U.S. Army Research Laboratory.

• **MRF** is an umbrella facility that supports a variety of advanced scientific research activities within the university and with external partners. The areas of research encompass many disciplines including, engineering, materials science, physics, chemistry, and biology.

• The **UNT Discovery Park**, a 550,000²ft former Texas Instruments facility, houses the **MRF** facilities

• **MRF** currently maintains and operates more than 20 instruments for advanced characterization and processing.
MRF History

- **2002**: UNT establishes College of Engineering in TI building (550k ft\(^2\) on ~300 acres)
  - Materials Science & Engineering Department founded under new College of Engineering
- **2004**: UNT establishes Center for Advanced Research and Technology (CART) under the Office of the Vice-President for Research
- **2004-2010**: CART funded with a Congressional Appropriation of ~$15M - used primarily for equipment purchases
- **2012**: UNT establishes Nanofabrication Cleanroom (NFCR)
- **2012-14**: UNT is successful in winning an NSF - ARI award - CART instruments centralized into dedicated lab space besides the NFCR lab space
- **2016**: CART & NFCR are merged into the Materials Research Facility (MRF)
- **2018**: UNT’s Additive Manufacturing Laboratory (AML) is being established and will become part of the MRF
Unique Coupling of 3 Instruments

FEI Tecnai G2 F20 S-Twin 200keV field emission scanning transmission electron microscope (S/TEM)

CAMECA local electrode atom probe (LEAP) instrument with added laser-pulsed evaporation technique

FEI Nova 200 NanoLab - a dual column ultra-high resolution field emission scanning electron microscope (SEM) and focused ion beam (FIB)
## MRF: Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Resolution Analytical TEM</td>
<td><img src="image1.png" alt="TEM" /></td>
</tr>
<tr>
<td>Dual Beam FIB/SEM</td>
<td><img src="image2.png" alt="FIB/SEM" /></td>
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<tr>
<td>Local Electrode Atom Probe (LEAP)</td>
<td><img src="image3.png" alt="LEAP" /></td>
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<tr>
<td>High Resolution X-ray Diffraction</td>
<td><img src="image4.png" alt="XRD" /></td>
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<tr>
<td>Environmental SEM</td>
<td><img src="image5.png" alt="SEM" /></td>
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<tr>
<td>X-ray Photoelectron Spectrometer</td>
<td><img src="image6.png" alt="XPS" /></td>
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<tr>
<td>Scanning Auger Nanoprobe</td>
<td><img src="image7.png" alt="SAES" /></td>
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<tr>
<td>Atomic Force Microscopy</td>
<td><img src="image8.png" alt="AFM" /></td>
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<tr>
<td>Variable Angle Spectroscopic Ellipsometer</td>
<td><img src="image9.png" alt="VAES" /></td>
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<tr>
<td>Raman Spectrometer</td>
<td><img src="image10.png" alt="Raman" /></td>
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# MRF Facilities & Instrumentation

## Multidimensional Characterization Lab
- Cameca LEAP 3000XHR Atom Probe Microscope
- FEI Nova 200 NanoLab Dual Beam FIB/SEM
- FEI Nova 230 NanoSEM FEG-SEM
- FEI Quanta 200 Environmental SEM
- FEI Tecnai F20 (200kV) Field Emission TEM
- J.A. Woolam Variable Angle Ellipsometer
- PHI Versaprobe II XPS/UPS
- PHI 670xi Scanning Auger Microscope
- Rigaku Ultima III XRD
- Skyscan 1172 µ-CT 3D imaging system
- Veeco Multimode Nanoscope III SPM
- Nicolet Almega XR Raman Spectrometer
- Thermo Nicolet 6700 FTIR Spectrometer

## Nanofabriation Cleanroom Lab
- 3000 ft² of clean space including Class 100 and Class 10,000 areas
- JEOL JSM-7001F SEM EBL pattern writer
- Heidelberg DWL 66-fs Maskless Lithography Laser Writer
- Oerlikon Leybold Ion Assist E-Beam & Sputtering Thin Film Deposition system
- Nanomaster NEE-4000 Dual E-Beam system
- Trovato 300C organic deposition system
- AGS RIE MPS-150
- KLA-Tenco D300 profiler

## Additive Manufacturing Lab (under construction)
- Optomec LENS 750 Direct Laser Deposition System
- Aconity MIDI Powder Bed SLM System
# MRF: External Users

## For Profit Institutions

<table>
<thead>
<tr>
<th>Acorn Technologies</th>
<th>EkoTek Coatings</th>
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<tbody>
<tr>
<td>Alcorn Laboratories</td>
<td>Entergris</td>
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<tr>
<td>Andrew Solutions</td>
<td>Raytheon</td>
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<tr>
<td>ATI Allvac</td>
<td>Shell</td>
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<tr>
<td>Atlas Copco</td>
<td>Halliburton</td>
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<td>ConocoPhillips</td>
<td>Johns Manville</td>
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<tr>
<td>Dominion Engineering</td>
<td>Microtech Lab</td>
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<tr>
<td>DRS Tech</td>
<td>Texas Instruments</td>
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## Non Profit U.S. Institutions

<table>
<thead>
<tr>
<th>Colorado School of Mines</th>
<th>Del Mar College</th>
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<tbody>
<tr>
<td>Ohio State University</td>
<td>Southern Methodist University</td>
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<tr>
<td>Florida International University</td>
<td>University of Dallas</td>
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<tr>
<td>Canadian National Research Council</td>
<td>University of Texas-Arlington</td>
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<td>Texas A&amp;M University</td>
<td>TWU (Westmoreland)</td>
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<td>University of Nebraska – Lincoln</td>
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<td>University of Oklahoma (Kane)</td>
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<td>University of Texas – Dallas</td>
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MRF: International Collaborations

**Australia:** University of New South Wales, Monash University, CSIRO  
**Brazil:** University of Campinas  
**Canada:** Queens University  
**Germany:** University of Mainz  
**India:** Indian Institute of Science, TIFR  
**Japan:** University of Tokyo, Shimane University,  
Japan Women's University, Tohuku University  
**Mexico:** Universidad Autónoma del Estado de México  
**Portugal:** University of Aveiro  
**Singapore:** Nanyang Technological University  
**Slovenia:** University of Ljubljana  
**South Korea:** KAIST, KAERI  
**U. K:** Univ. of Strathclyde, University of Birmingham, Imperial College
MRF organization

- MRF is a facility under the VPR’s office, under the administration of the Assoc. VPR

- MRF director in charge of day to day operations, policy development for equipment usage, charging for usage, user training, maintenance, enhancement, and acquisition of MRF equipment etc.

- MRF expenses (covered upfront by the VPR’s office):
  - Service contracts (7 critical characterization equipment out of 15)
  - Repairs and upgrades
  - Consumables and supplies
  - Technical staff support (1 facilities manager + 2 technical staff)

- MRF has a faculty advisory committee to advise and aid the MRF Director and the VPR’s office

- MRF faculty advisory committee also aids in the development of stronger links between MRF and industrial partners interested in using MRF equipment
MRF Accounting and Billing

- **MRF accounting & billing procedures**
  - Have been well-established and auditable
  - Instrument access and time charges
    - handled by Facility Online Management (FOM) System
  - Various enticements have been engineered to increase research and academic output

- **MRF Small Fee Grant Program**
  - Sponsored research matching grant to leverage current grants
  - Seed/bridging grant to develop new research grants
  - Terminal research grant for completion of a student’s degree
MRF integration into Education

- **Training of graduate and undergraduate students in the use of advanced characterization of processing equipment**

- **Impact on undergraduate education**
  - Senior design projects have a separate budget amount (provided by the department) for the use of MRF equipment
  - Juniors and seniors trained on some of the equipment as needed
  - Introductory MSE course has a whole lecture period devoted to detailed tour of the facility including specific examples of instrument use

- **Impact on graduate education**
  - Course on materials characterization includes substantial use of MRF facilities
  - Active use by graduate students in their research projects

- **Middle and high school students and their science teachers are brought in on a regular basis for tours of the facility**
MRF challenges

- **Recovery from user fees**
  - User fees kept relatively low
  - VPR’s office offers effective subsidy to internal UNT faculty users by paying for part of the user fees
  - MRF offers small fee grant program to promote usage
- Total annual recovery from user fees is only ~15% of total MRF expenses
- MRF usage is not sufficient to generate required user fees
  - Faculty complain that they do not have enough budgeted in their grants/contracts for using shared facilities
  - Faculty try to work with collaborators, in some cases international collaborators, to get their research done, without having to pay user fees
MRF challenges

- **Training of users**
  - Less than required MRF-dedicated staff for training on equipment in an expedited manner
  - Faculty are not always cooperative in having their trained senior graduate students/post-docs to help out with training
  - Requirement of training differs depending on the specific equipment