National Renewable Energy Laboratory Lightweight Materials (LightMAT) Capabilities

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LightMAT Lightweight Materials Consortium

NREL NATIONAL RENEWABLE ENERGY LABORATORY

PROCESSING & MANUFACTURING

This catalytic reactor converts chemical intermediates into acrylonitrile. *Photo by Dennis Schroeder, NREL*

- Renewable Nitrile Precursors for Lightweight Fibers and Polymers
  - NREL hosts a fully automated reactor system with tandem reactor beds, designed to produce acrylonitrile or other nitrile compounds from bio-derived feedstocks
  - This capability allows for:
    - The ability to handle hazardous reactions relevant to the synthesis of nitrogen-containing compounds at moderate scales
    - Real-time analysis of reaction products
    - Ability to collect, store, and transfer reaction products from NREL to collaborating institutions, or perform in-house synthesis of polymer materials

Glove boxes are used for comprehensive inert gas processing. *Photo by Dennis Schroeder, NREL*

- Materials from Liquid Precursors and Inert Atmosphere Materials Processing
  - The Atmospheric Processing Platform offers powerful capabilities with integrated tools for depositing, processing, and characterizing materials—all within an inert gas environment
    - With more than 15 years in precursor ink development, NREL offers a cluster of six coupled gloveboxes for comprehensive inert gas processing

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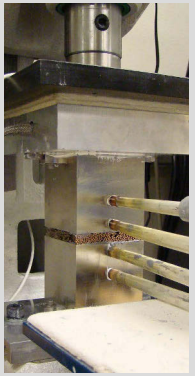
CHARACTERIZATION

- Thermal Characterization and Modeling of Materials/Interfaces
  - NREL focuses on advanced thermal and thermomechanical aspects for materials and interfaces for numerous applications, and performs comprehensive evaluation through experimentation and modeling
- High-Throughput Experimental Capabilities for LightMAT Alloys
  - High-throughput experimental (HTE) capabilities include combinatorial synthesis, spatially resolved characterization, and semi-automated data analysis
    - The high-throughput combinatorial screening of chemical compositions may identify new LightMAT alloys with desired structural, mechanical, and corrosion-resistance properties, particularly for chemically complex materials (three or more elements)
- NREL can provide extensive characterization of non-aqueous electrochemistry from reaction mechanisms to system-level evaluations
- NREL Offers Electrochemical Characterization Tools
  - Fundamental characterization
  - Durability evaluation
  - Remaining useful estimation (RUL)
  - Electrochemical sensing of trace impurities
  - Corrosion studies
  - Destructive physical analysis
- Reliability and Mechanical Characterization and Analysis
  - NREL researches and investigates advanced thermomechanical and reliability aspects
    - NREL identifies failure mechanisms via experimental characterization and modeling
    - NREL provides pathways to changing process conditions to improve reliability

This dual column tabletop universal system has an environmental chamber with a temperature range from -100°C to 350°C for capturing temperature-dependent material properties. *Photo by Doug DeVoto, NREL*



Thermal transmittance setup for measuring thermal conductivity of materials and interfaces. *Photo by Emily Cousineau, NREL*

Multiple chambers allow for simultaneous evaluation of samples at various ramp rates, dwell times, or mean cycle temperatures. *Photo by Doug DeVoto, NREL*

Top view of a thermoreflectance experiment setup designed to characterize thermal conductivity of thermal interface materials. *Photo by Xuhui Feng, NREL*

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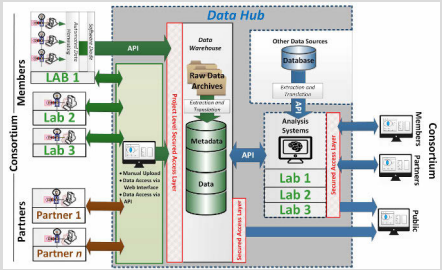
COMPUTATIONAL TOOLS

- NREL's Computational Science Center Offers both a Laboratory Information Management System (LIMS) and a High-Throughput Materials Discovery Data System
  - This data ecosystem can handle both experimental LIMS data and high-throughput materials and simulation data generated on high-performance computers
    - LIMS can autonomously collect data for archiving and processing
    - Researchers can upload analyzed data into the system
    - LIMS can track samples and experimental projects
    - The Materials Discovery system can be instantiated as as focused capability for LightMAT
    - No other laboratory has this capability
- NREL High-Performance Computing (HPC) Facility
  - NREL's system and User Application, Data and Learning Support Capability enable researchers to exploit the potential of the largest HPC environment in the world
- Computational Materials Science and Chemistry of Alloys and Disordered Materials
  - This capability is for modeling disordered and metastable materials, including alloys and organic materials, at multiple fidelities from the atomic scale to the mesoscale.



The general Data Hub architecture gives members and partners of the LightMAT consortium the ability to share and archive data efficiently and securely. *Image by Robert White, NREL*

The Peregrine HPC is capable of one million billion calculations per second. *Photo by Dennis Schroeder, NREL*

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