

NATIONAL LABORATORY MATERIALS SYNTHESIS CAPABILITIES

State-of-the-Art Materials: From Discovery to Marketplace

DESIGN

SYNTHESIZE

CHARACTERIZE

UNDERSTAND

APPLY



Theory



Chemical

Physical

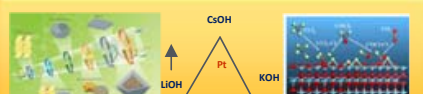


UHV

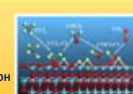
SXS
STM/AFM

FTIR
RAMAN

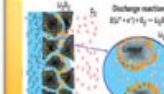
HRTEM



Experiment



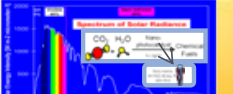
Theory/Modeling



Metal-Air Batteries



Fuel Cell ↔ Electrolyzer

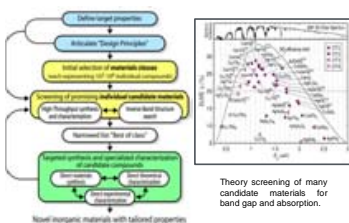


Solar Energy conversion of CO₂ to fuel

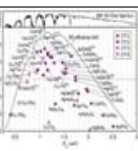
National Laboratories provide world-leading, innovative, and agile materials science and technology solutions for energy security missions. Multi-interdisciplinary teams consisting of chemists, materials scientists, physicists, computational scientists, and engineers are exploring uncharted territories for development of novel, cost effective and environmentally friendly energy solutions to meet global energy needs.

Computational Research

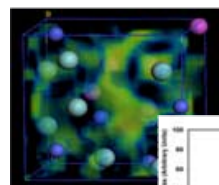
NREL researchers revolutionize the discovery of functional materials by developing an Inverse Design approach powered by theory guiding experiment.



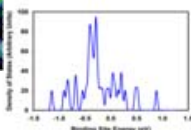
Novel inorganic materials with tailored properties



Theory screening of many candidate materials for band gap and absorption.



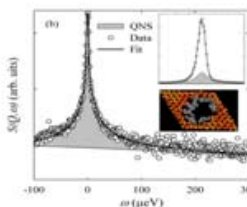
Predicting Atomic Hydrogen Diffusion in a Metallic Glass PEM Fuel Cell



Computational chemistry is used to predict, understand, and control where and how to place individual atoms and molecules to achieve desired material properties.



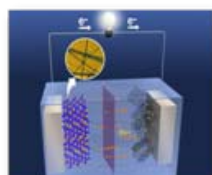
Nano-Confined Molecular Dynamics via Quasi-Elastic Neutron Scattering (QENS) provides information on the interfacial dynamics at the ps timescale and can probe weak interactions such as hydrogen bonding.



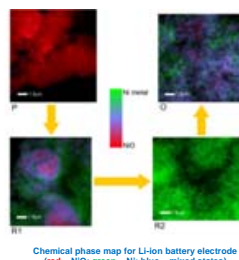
Unique Materials

Sodium Ion-based Battery Cells

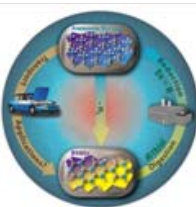
Researchers at PNNL developed a method that improves the electrical capacity and recharging lifetime of Na-ion rechargeable batteries.



In-situ studies of lithium-ion battery electrodes revealed the location and chemical speciation of the Ni component, and how electronic and chemical changes took place as a function of the applied charge at the cathode.



Chemical phase map for Li-ion battery electrode (red = NiO; green = Ni; blue = mixed states)



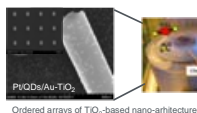
Novel Materials

LANL in partnership with PNNL, several academic institutions, and Dow Chemical Co. developed several chemically efficient, low cost re-synthesis routes to ammonia borane, a promising hydrogen storage compound, from its 'spent fuel'.

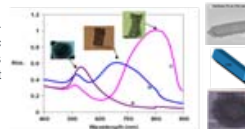


World-Class Innovative Nano-Architectures

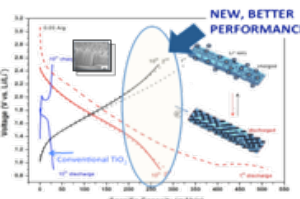
SRNL researchers produced state-of-the-art multifunctional plasmonic Pt-Au and Pt hollow nanomaterials with tunable properties for direct methanol fuel cells applications.



Ordered arrays of TiO₂-based nano-architectures



We amassed a library of unique nanophotocatalysts for renewable fuel production from carbon dioxide (CO₂) and water.



Advanced Nanoporous Carbons

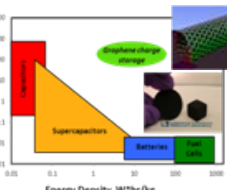
LLNL researchers produced novel nanoporous carbon materials with high surface areas and tunable pore sizes with high electrical conductivity and robust mechanical properties.



Quantum Dot Film: Photonics



Self-assembled carbon nanotubes



Nano- Films and Nano-Membranes

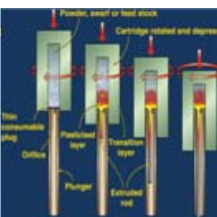
AML-SNL and SRNL developed several synthetic routes to produce bulk, thin film and nanomaterials for coating surfaces.



Outstanding Materials and Technologies

Thermoelectric Power Generator (TEP) Heat into Electricity

A novel, low cost, and scalable non-equilibrium synthesis process was developed for high performance thermoelectric material.

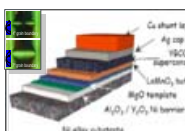


Friction Stir Extrusion

ORNL researchers developed a revolutionary solid-state materials synthesis and recycling technology for energy-efficient sustainable manufacturing.



High TC Superconductivity (HTC) Wires for the Grid Power Grid System of the Future



Collaborating with American Superconductor Corporation to deploy the technology.

Development of the sub-atmospheric growth process at BNL enables reel-to-reel production of long length HTS tapes

