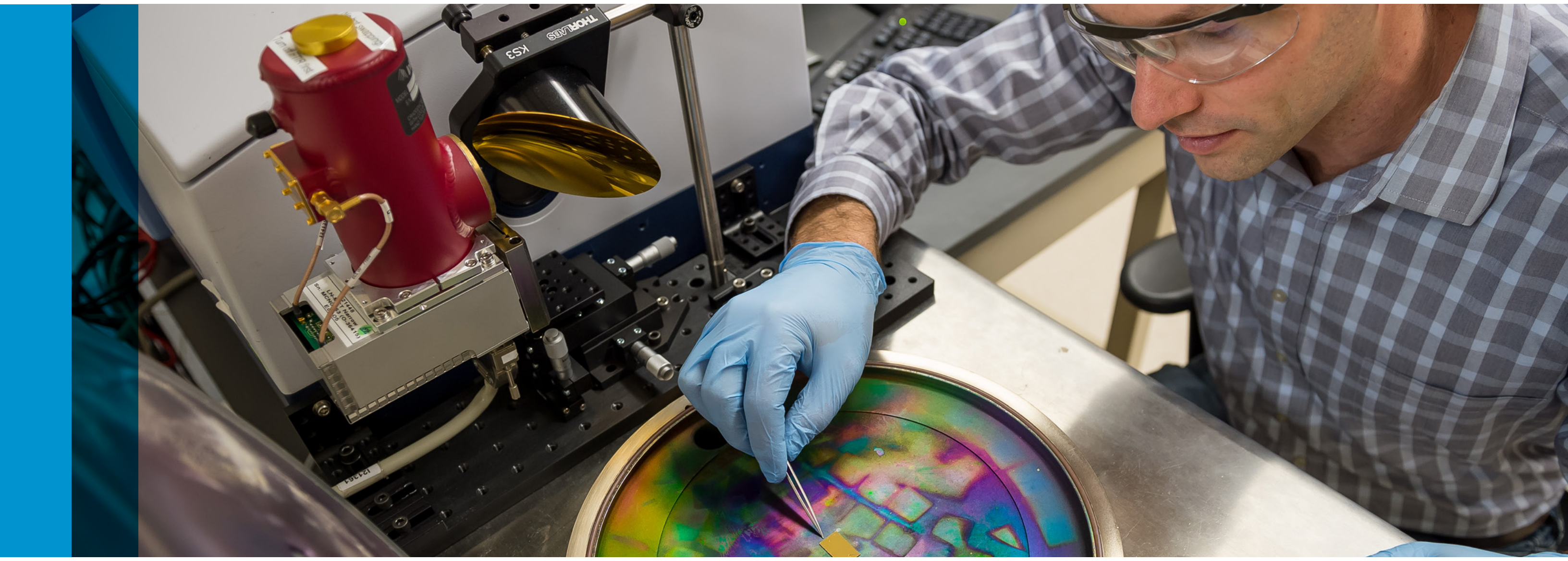
Argonne NATIONAL LABORATORY

MATERIALS SCIENCE DIVISION

Unraveling the structure and function of novel materials to solve America's energy challenges



An MSD scientist probes fundamental structure-function relationships in water purification materials.

The work done in Argonne's Materials Science Division (MSD) pursues the foundations of how electrons, atoms and molecules interact and organize themselves to produce remarkable and sometimes unexpected properties of matter. Our mission is to design, create and understand new materials and systems that will have a lasting impact on science and form strong foundations for the technologies of tomorrow.

OUR RESEARCH PORTFOLIO

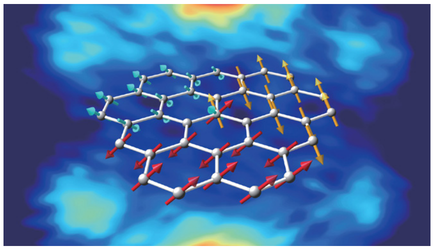
The MSD research portfolio emphasizes defects and interfaces as a unifying theme for exploring condensed matter physics and materials science. This emphasis emerges from an understanding that exciting new science opportunities lie beyond crystalline perfection in the natural or artificial heterogeneity of matter.

The MSD research portfolio has three focus areas:

- Pursuing a deep, fundamental understanding of the quantum realm, where individual electrons cooperate to make new energy and information science revolutions possible.
- Exploring the dynamical properties of energy, matter and charge as they encounter defects or traverse complex material interfaces to deliver new functionality.
- Revealing a deeper understanding of soft-matter structures, which impact a broad range of applications from battery electrolytes to microscale "robots" that can dynamically self-assemble.

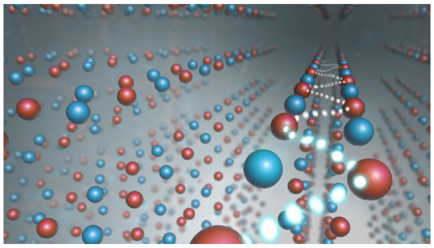
OUR CAPABILITIES

Our research capabilities bridge internationally recognized strengths in design and synthesis of both hard and soft matter, world-leading experimental and theoretical condensed matter physics, unique skills in materials modeling and leadership in scattering and imaging science.



Quantum magnets studied in MSD offer potential breakthroughs for information technology.

Efforts across the division are strengthened by close connections to three world-class U.S. Department of Energy User Facilities at Argonne: the Advanced Photon Source, the Center for Nanoscale Materials and the Argonne Leadership Computing Facility. Each of these facilities contributes to the fuller integration of the theoretical, computational and experimental approaches in MSD that together yield new insights into material properties and function.



Results from a new method for analyzing the crystalline microstructure of cathode materials for next-generation batteries.

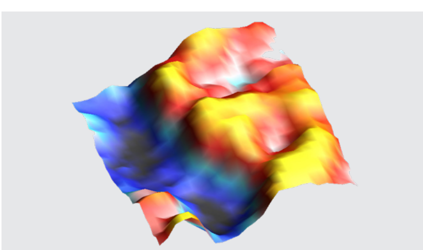
OUR PARTNERSHIPS

MSD pursues its highly collaborative research by assembling teams of scientists with expertise in synthesis, characterization and theory. The aim is to achieve a better understanding and appreciation of the small-scale phenomena that lead to the exciting materials behavior that we create and understand.

Key to success is the contributions of our many partnerships with other Argonne divisions and collaborators from academia, industry and other national laboratories.

LOOKING AHEAD

The advent of artificial intelligence, the rise of quantum information science and technology, the growth of microelectronics and the importance of materials sustainability will all play key roles as MSD research evolves.



Advanced imaging enables design and understanding of functional materials, such as complex ferroelectric composites, for energy harvesting or computer memories.

TEAMWORK

The Materials Science Division is home to twelve research groups. Each has a unique identity, but they work in concert to further the goals of Argonne and the Department of Energy.

ASP GROUP
Develop techniques to detect and characterize materials in harsh and complicated environments.

COMPUTATIONAL MATERIALS
Use innovative computational methods to understand and predict fundamental behavior of solids, liquids and nanostructures.

CONDENSED MATTER THEORY
Understand condensed and soft matter physics, including superconductivity, magnetism, quantum mesoscopic phenomena and the behavior of topological, low-dimensional and nonequilibrium systems.

EMERGING MATERIALS
Design, synthesize and understand new quantum materials in single-crystal form for basic science and early-stage technology.

ENERGY CONVERSION AND STORAGE
Identify and control properties of electrochemical interfaces at the atomic and molecular level for energy storage applications.

FUNCTIONAL NANOSCALE HETEROSTRUCTURES
Explore behavior of magnetic, ferroelectric and resistive switching structures at the nanoscale, in addition to nanocomposites and energy storage materials.

MOLECULAR MATERIALS
Discover and design new materials for next-generation energy storage systems and catalysts for energy conversion.

NEUTRON AND X-RAY SCATTERING
Investigate the structure and dynamics of energy materials that emerge from the complex short-range correlations, defects and interfaces, using neutron and X-ray scattering techniques.

QUANTUM INFORMATION SCIENCE
Develop quantum-relevant materials for basic quantum research and applications in new scalable technologies.

SOFT MATTER AND BIOMOLECULAR MATERIALS
Create synthetic materials inspired by biological systems that self-assemble, using precision synthesis, theory and computation.

SUPERCONDUCTIVITY AND MAGNETISM
Study novel phenomena associated with superconductivity and magnetism in crystals, in thin films and at interfaces for both fundamental understanding and applications.

SYNCHROTRON STUDIES OF MATERIALS
Innovate cutting-edge X-ray methods at synchrotrons and X-ray free electron lasers to understand the fundamental dynamics and properties of critical materials for technology.

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