THE Ames Laboratory

Creating Materials & Energy Solutions

Program and Research Thrusts

The Ames Laboratory carries out interdisciplinary research focused on national issues. The Lab is at the forefront of materials research, high-performance computing and analytical science. The Lab's research falls within five program areas:

- Materials Sciences and Engineering
- Applied Mathematics and Computational Sciences
- Chemical and Biological Sciences
- Environmental and Protection Sciences
- Simulation, Modeling and Decision Science

Materials Synthesis and Processing

An internationally recognized leader in materials sciences, the Ames Laboratory develops new ways to produce and use existing materials. The Lab also creates new, environmentally friendly materials to meet tomorrow's scientific challenges. Ames Lab is widely known for its expertise in the synthesis and processing of rare-earth materials with unique purity and crystal structure, and high desirability. Other high-tech materials under study at the Lab include metals and intermetallics, ceramics and polymers.

Chemical and Analytical Sciences

Ames Laboratory researchers are established leaders in creating useful analytical tools, pioneering the use of inductively coupled plasma spectroscopy — a sensitive, selective tool for multielement analysis that is now commonplace in laboratories worldwide. Other areas under exploration include: understanding the surface properties of quasicrystals, understanding the structure and dynamics of fuel-cell membranes using Nuclear Magnetic Resonance technology, studying the chemical and physical aspects of chemical carcinogenesis through advanced laser techniques, and developing methods for analyzing the contents of nanoscale samples

Complex Solids

Ames Laboratory is home to world-renowned experts in the area of complex intermetallics, including quasicrystals. Complex intermetallics are materials with large unit cells. Quasicrystals are materials that lack traditional crystalline symmetry. Ames Laboratory researchers are probing these complex materials and other complex metal-rich solids to understand the relationship between their novel properties and structure. Seminal aspects of this research include microscopic and mesoscopic morphology, atomic locations, electronic structure, surface structure, interfacial growth, friction, and chemical reactivity. Researchers address fundamentals of designing and perfecting atom- and energy-efficient synthetic methods

Novel Materials

for new, complex metal-rich materials that offer potential for thermoelectrics, magneto-responsive processes, molecular storage, coatings and other surface-related applications.

High-performance Computing

Advanced computing systems can deliver more accurate and reliable results, but scientists sometimes have difficulty adapting research problems to these computers. Researchers at Ames' Scalable Computing Laboratory use a variety of approaches to make parallel computing more accessible. Lab scientists have also developed a method for evaluating the performance of computers, which promises to revolutionize the way computers are compared.

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Environmental and Protection Sciences

Ames Laboratory is helping DOE identify and develop new technologies that can be applied to national problems that affect the environment, industrial operations and forensic investigations. Current research activities include:

- Investigating the use of atomic spectroscopy in analyzing crime-scene evidence and for continuous-emission monitoring of heavy metals released into the environment.

- Developing analytical methods and instrumentation for matching the composition of trace evidence, recovering defaced serial numbers and examining bomb-blast evidence to determine force and location.

Condensed Matter Physics

This program is focused on the synthesis, development and characterization of new materials and on the systematic study or discovery of phenomena relevant for materials utilizations in various energy technologies. This scientific focus includes fundamental research in neutron scattering. X-ray scattering, optical properties of solids and surfaces, new materials, superconductivity, magnetic materials, photonic bandgap and left-handed materials, magnetic molecules and clusters, optical and surface physics, spin dynamics, and computational materials sciences. CMP scientists are world renowned for their ability to develop, generate and investigate areas of interest. In most cases, the thrust of the research efforts is the investigation of new phenomena or the creation of new materials exhibiting unusual and potentially useful properties.

Solid-state Nuclear Magnetic Resonance Imaging

Ames Laboratory researchers develop and apply transient techniques in solid-state nuclear magnetic resonance, or NMR, to probe the chemical and physical properties of materials involved in heterogeneous catalysis, surface science and materials science. The work on catalysts, which in recent years constituted most of the research effort, focuses on studying the properties of surfaces, as well as the molecular structure, dynamics and reactions of the adsorbed species.

Development of new solid-state NMR methods for these studies is the second major research area. Current efforts include the development of techniques based on multiple-quantum MAS, or magic angle spinning, NMR, homo- and hetero-nuclear correlation experiments for spin-1/2 and quadrupolar nuclei, methods utilizing ultrafast MAS and methods for measuring internuclear distances in solids.

Specialized Research Centers

- The Lab's Materials Preparation Center is recognized by the worldwide research community for its unique capabilities in the preparation, purification and characterization of rare-earth, alkaline-earth, and refractory metal materials.

- The Biorenewable Resources Consortium is dedicated to the development and utilization of agriculturally derived alternatives to petrochemicals and other nonrenewable fossil resources.

- The Center for Catalysis is dedicated to the development of useful, practical catalysts and sustainable green chemistry methods.

- The Scalable Computing Laboratory improves parallel computing through clustering techniques for use in scientific and engineering computation. The SCL delivers supercomputing power at a fraction of the cost of traditional supercomputers.

- The Center for Physical and Computational Mathematics develops high-performance computing methods and hardware and conducts research in the physical, mathematical and engineering disciplines.