ADVANCED ENERGY MATERIALS

NETL is a U.S. Department of Energy national laboratory that drives innovation and delivers technological solutions for an environmentally sustainable and prosperous energy future. Through its world-class scientists, engineers and research facilities, NETL is ensuring affordable, abundant and reliable energy that drives a robust economy and national security, while developing technologies to manage carbon across the full life cycle, enabling environmental sustainability for all Americans, advancing environmental justice and revitalizing the economies of disadvantaged communities.

NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

The **Advanced Energy Materials program within the Crosscutting Research Portfolio** focuses on material discovery and development that will lower the cost and improve flexibility and reliability while enabling high efficiency, low-carbon performance.

Materials of interest are those that enable components and equipment to perform in the high-temperature, high-pressure, corrosive environments of an advanced energy system with specific emphasis on durability, availability and cost both within, and across, each of the following four primary platforms: Advanced Materials Development; Supply Chain Development; Work Force Development; and High-Performance Computing for Materials (HPC4Mat).

In accordance with the Fiscal Year 2022 Presidential Budget Request, NETL will evaluate the impacts of hydrogen on materials to develop models which are critical to understanding hydrogen-related impacts. This will ultimately help establish a new domestic supply chain of hydrogen-resistant materials.

ADVANCED MATERIALS DEVELOPMENT — This effort uses Integrated Computational Materials Engineering (ICME) techniques to create and model cost-effective structural and functional materials for advanced fossil energy power generation technologies. Development focuses on advanced manufacturing methods for high-performance materials and computational materials modeling as enabling technologies.

NETL also leads a national laboratory consortium, eXtreme environment MATerials (XMAT), dedicated to changing the paradigm on how materials are conceived and developed. The consortium, using the unique capabilities of several of the Energy Department's National Laboratories, is designing a new generation of computational and experimental validation toolsets aimed at accelerating the discovery, scale-up and manufacture of advanced energy materials capable of long-life and affordable, harsh environment operation. XMAT is led by NETL, and members include Ames Lab, Idaho National Lab, Lawrence Livermore National Lab, Los Alamos National Lab, Oak Ridge National Lab, and Pacific Northwest National Lab.

SUPPLY CHAIN DEVELOPMENT — The Advanced Ultra-Supercritical consortium developed and characterized high temperature materials and manufacturing technologies that are now being exploited in applications such as natural gas combined cycles, concentrated solar, advanced cycles such as supercritical CO_2 power cycles, and high efficiency plants. The recently completed supply chain development effort included RDD&D, large-scale component manufacturing and field erection trials, American Society of Mechanical Engineers (ASME) code cases, and techno-economic analyses that readied the domestic supply chain to support construction of advanced power generation technology power plants. Moving forward, future development activities will continue to focus on enhancing the nation's supply chain of advanced materials and components to ensure the reliable construction and repair of thermal power applications.

WORK FORCE DEVELOPMENT — DOE supports the education and training of advanced technical workers. The workers are trained in skills necessary to manufacture and repair components suitable for fossil-based power plants applications and other industries. These workers could find employment in the manufacture and repair of components used in fossil power plants and in the aviation, automotive, and petrochemical industries. This focus area provides training in target skills while addressing the employment and training needs of the local and regional workforce. These training programs are created in collaboration with community partners and in coordination with existing economic development strategies to support worker training for coal and powerplant communities.

HIGH-PERFORMANCE COMPUTING FOR MATERIALS (HPC4MAT) — This activity aims to utilize the high-performance computing (HPC) resources of DOE's national labs to collaborate with industry on developing new or improved materials and resolving materials challenges for their applications. Projects selected under HPC4Mat will have access to the labs' HPC facilities, as well as the labs' expertise in modeling, simulation, and data analysis. The HPC4MAT is part of a larger HPC4Energy Innovation Initiative, a DOE-wide effort comprising FECM, EERE, the Office of Science, and the National Laboratories. These government entities collaborate with companies to make material advancements that could save millions of dollars in fuel and maintenance across sectors.

ADDITIONAL BENEFITS OF ADVANCED MATERIAL DEVELOPMENT:

- Utilizes multi-scale computational methods to predict alloy behavior in a variety of relevant environments.
- Develops techniques for the virtual and rapid design of materials using advanced manufacturing.
- Facilitates process intensification for lowering cost and reducing material requirements.
- Accelerates the selection and qualification for service of materials.
- Strengthens the nation's supply chain for high-temperature materials.

In conclusion: Given the cross-cutting nature of materials R&D across DOE broadly, the Fossil Energy Crosscutting Materials Program is shifting our funding to focus on areas that will have a significantly greater impact on achieving a net-zero carbon economy by mid-century.

*Cover image is a photo of a high nickel superalloy pipe (Inconel 740H™) after extrusion. Photo (2021) is courtesy of Special Metals, a PCC Company.

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