NATIONAL ENERGY TECHNOLOGY LABORATORY

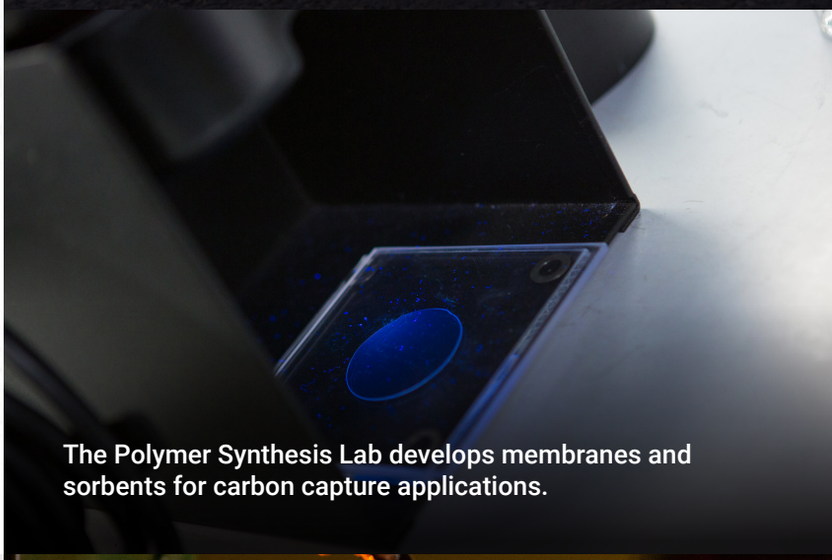
Advanced Energy Materials

NETL is a national leader in the discovery, development and deployment of advanced materials that support the nation's energy systems and industrial infrastructure. Leveraging expertise in computational modeling, laboratory research and field validation, NETL advances both high-performance structural materials for extreme environments and functional materials critical for next-generation sensing, separations, catalysis and energy conversion technologies. These advancements strengthen energy delivery, enhance manufacturing competitiveness and enable new opportunities across sectors.

R&D Applications

- Advanced, Intelligent Manufacturing of Alloys
- Advanced Material Performance in Severe Environments
- Corrosion-Resistant Materials
- Coatings and Surface Treatments
- Alloy-Based Catalysts and Electrochemical Technologies
- Cathode Infiltration Technologies
- Catalysis for Material Development and Computational Work
- Sorbents for Gas Separation and Mineral Recovery
- Advanced Sensing Technology for Infrastructure Resilience

The Metals Melting Facility designs unique materials for use in extreme environments.



The Polymer Synthesis Lab develops membranes and sorbents for carbon capture applications.

Cerium Alloy Strengthens Pipelines

Structural materials researchers at NETL have produced a stronger pipeline by using the rare earth element cerium to create a tougher steel alloy. The cerium eliminates the negative impacts of sulfur and oxygen impurities during the steel manufacturing process. Testing shows that the new alloy can improve the steel's ability to absorb energy and resist cracking by up to 50%.

Research Highlights

New Alloy Capable of Operating Above 2,400°F

A collaboration between NETL and Oak Ridge National Laboratory has developed and manufactured a crack-free alloy that can operate at temperatures above 2,400°F without melting. The alloy is rich in niobium and combines seven elements to reach a melting point at least 48% higher than previous nickel and cobalt alloys. Its light weight and heat resistance could be useful for gas turbine engines like those in airplanes.

Scalable Anti-Corrosion Coating for Pipelines

Internal corrosion is a crucial problem for natural gas pipelines. NETL researchers have developed a superhydrophobic porous coating that is corrosion-resistant and can be produced at a large scale. The new spray coating method changes how the nanoparticles are assembled, reducing the assembly time and eliminating wastewater.

Accelerating Ultradeep Drilling Technology

NETL is developing a novel, ultradeep drilling simulator to better understand drilling dynamics. The simulator will help improve the technology's rate of penetration and materials performance at temperatures exceeding 480°F and pressures up to 30,000 pounds of force per square inch, which is up to three times greater than the pressure and temperature ranges of other drilling simulators.

High-Performance Gas Separation Membrane

A collaboration between NETL and Idaho National Laboratory successfully created a viable coating suitable for high-performance gas separation membranes (U.S. Patent No. 11,866,555). The innovation is particularly effective for CO_2 separation from flue gas. This product is the first successful cross-linking technique for polyphosphazenes that allowed the material to retain most of its properties for CO_2 separations.

Publications

- Hardy, M. C., Detrois, M., McDevitt, E. T., Argyrakis, C., Saraf, V., Jablonski, P. D., & Tin, S. (2020). Solving recent challenges for wrought Ni-base superalloys. Metallurgical and Materials Transactions A, 51, 2626-2650. https://doi.org/10.1007/s11661-020-05773-6.
- Oleksak, R. P., Detrois, M., Jablonski, P. D., Rozman, K. A., & Doğan, Ö. N. (2024). Influence of Rare Earth Ce Additions on Microstructure and Mechanical Properties of Experimental Pipeline Steels. steel research international, 95(3), 2300652. https://doi.org/10.1002/srin.202300652.
- Pham, V. H., Wang, C., Gao, Y., Weidman, J., Kim, K. J., & Matranga, C. (2024). Synthesis of Microscopic 3D Graphene for High-Performance Supercapacitors with Ultra-High Areal Capacitance. Small Methods, 8(9), 2301426. https://doi.org/10.1002/smtd.202301426.
- Romanov, V. N. (2022). Adversarial ensemble modeling of multi-modal mechanical properties for iron-based alloys. JOm, 74(4), 1414-1422. https://doi.org/10.1007/s11837-022-05163-w.
- Xiang, F., & Hopkinson, D. (2024). Scalable Anti-Corrosion Coating Based on Porous Superhydrophobic Structure. National Energy Technology Laboratory (NETL), Pittsburgh, PA, Morgantown, WV, and Albany, OR (United States). https://www.osti.gov/servlets/purl/2459261.

NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to innovating and accelerating the nation's energy solutions in hydrocarbon, geothermal energy and critical minerals production. With research sites in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL operates as one laboratory to create advanced energy technologies that support DOE's mission and enable affordable, reliable and secure energy to fuel human prosperity.

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December 2025