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Lightweight Materials

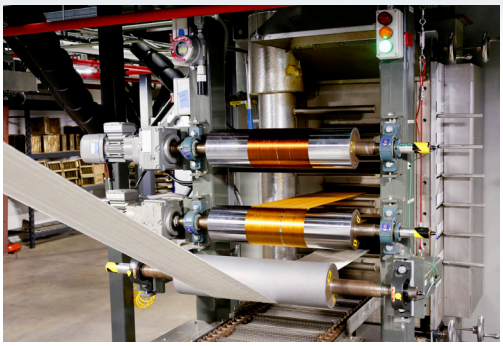
Oak Ridge National Laboratory's Lightweight Materials research and development supports the Department of Energy Vehicle Technologies Program with activities focused on the development and validation of advanced materials and manufacturing technologies to significantly reduce light and heavy duty vehicle weight without compromising other attributes such as safety, performance, recyclability, and cost.

Because it takes less energy to accelerate a lighter vehicle, replacing cast iron and traditional steel components with lightweight materials can directly reduce fuel consumption. It also allows cars to carry advanced emissions control equipment, safety devices, and integrated electronic systems without becoming heavier. Lightweight materials are especially important for improving the efficiency and range of hybrid electric, plug-in hybrid electric, and electric vehicles because they offset the weight of power systems such as batteries and electric motors.

In the short term, vehicle weight reduction can be achieved by replacing heavy steel components with materials such as high-strength steel, aluminum, magnesium or polymer composites. While the properties of these materials are well established, better and more cost effective technologies and processes are needed for manufacturing, joining, modeling, and recycling. To better understand the properties of these materials and the processes required to maximize their benefits, ORNL conducts lightweight materials research in several areas: materials development, properties and manufacturing, computational materials science, and multi-material enabling.

Materials Development

Develop lower cost, more environmentally friendly methods for producing carbon fiber, magnesium ingot and 3rd generation advanced high strength steels.



Recent Accomplishments

- Plasma-based advanced oxidation processing technique developed for polyacrylonitrile (PAN) precursors that reduces carbon fiber costs by increasing production speed threefold
- Friction stir spot welding of advanced high-strength steels provides potential for robust, high-speed, economical methods of joining advanced high-strength steels
- Novel method for forming advanced high strength steel to aluminum alloy joints for chassis applications
- Tools to predict polymer composite properties and behavior of injection molded thermoplastics used in vehicles
- Conversion of textile-based PAN to carbon fiber for lower cost carbon fiber for automotive use
- Ultrasonic solid-state spot-welding process enables high-rate, reliable joining of dissimilar metals

Properties and Manufacturing

Improve properties (such as strength, stiffness, ductility or corrosion prevention) and manufacturability (such as production rate, near-net shape forming or high throughput) of a variety of metals and polymer composite materials.

Modeling and Computational Materials Science

Provide supporting technologies necessary for full system implementation such as joining methods, corrosion prevention techniques, predictive models, and other computational tools as well as aid in the development of new, better alloys or composite architectures.

Multi-Material Enabling

Develop and implement new joining methods, inspection techniques and the systems analysis necessary to incorporate new materials into future automotive designs.

Develop method for joining dissimilar materials in a repeatable and reliable manner while minimizing corrosion and increasing joint durability.

Facilities

Carbon Fiber Composites Laboratories

Address utilization of lower-cost processes and precursor materials for production of carbon fibers and the development of more energy-efficient, cost-effective processes for producing composite materials for vehicles. Equipment includes melt-spinning setup, robotic preforming machine, test machine for automotive crashworthiness, carbon fiber and precursor evaluation line and pilot-scale carbon fiber conversion line.

Carbon Fiber Technology Facility

Established with funds through the American Recovery and Reinvestment Act of 2009, the Carbon Fiber Technology Facility offers a highly flexible, highly instrumented carbon fiber line for demonstrating advanced technology scalability and producing market-development volumes of prototypical carbon fibers.

Materials Science Facilities

Facilities encompass extensive laboratory capabilities and innovative research in materials processing, joining, and forming.

High Temperature Materials Laboratory

HTML supports development of advanced materials with one of the most comprehensive and powerful collections of materials characterization instruments in the world.

ORNL 2012-G00671R/tcc