US Advanced Manufacturing initiative opens R&D institute on fiber-reinforced composites

www.iacmi.org

Composites that combine polymer resins with reinforcing carbon or glass fibers are lighter and stronger than steel. They impart strength and stiffness to aircraft, satellites, military vehicles, and luxury cars without adding bulk.

These fiber-reinforced composites could also help create the next generation of lightweight energy-efficient vehicles, larger wind turbines that produce more energy, and resilient compressed gas storage tanks for vehicles that run on natural gas or hydrogen. But composites are expensive, energy-intensive to manufacture, and difficult to recycle.

To overcome these barriers, the US federal government launched the Institute for Advanced Composites Manufacturing Innovation (IACMI) in January. The five-year, $259 million initiative led by the University of Tennessee, Knoxville, will drive innovation in advanced composite materials, manufacturing, and recycling. The goal is to develop high-throughput, low-cost, energy-efficient processes to produce and recycle composites so that they can be widely used by the automobile and renewable energy industries. There will also be a push to develop new kinds of composites and novel applications.

"Composites have been around for decades," said Craig Blue, Director of the Advanced Manufacturing Office at the Oak Ridge National Laboratory (ORNL) and CEO of the Institute. "The primary user has been aerospace. One major impediment to the prolific usage of composites is their cost and the energy intensity of the materials."

The IACMI's stated goals are to lower the cost of carbon-fiber-reinforced polymers by 25%, reduce the energy used in manufacturing of such composites by 50%, and to increase the recyclability to 80%.

Five major research centers will be launched under the IACMI, four of those based in Midwestern states where nearly 70% of the US automobile production is carried out. The Vehicles Application Center will be based at Michigan State University; the Compressed Gas Storage Application Center will be led by the University of Dayton Research Institute in Ohio; and the Wind Turbine Application Center will be led by the National Renewable Energy Laboratory in Colorado. There will be two enabling technology centers: the Composites Virtual Factory HUB at Purdue University, which will create tools to model and simulate the manufacturing phenomena under development at the other IACMI centers; and the Materials and Processing Enabling Technology Center at the University of Tennessee.

These five centers, along with the University of Kentucky and ORNL, are the IACMI's seven core partners. The initiative also involves a 122-member consortium of other universities and national laboratories, as well as industry leaders including BASF, Dow Chemical, Honda, and Boeing. These partners will provide $189 million in funding, with another $70 million from the US Department of Energy (DOE) Advanced Manufacturing Office.

Blue said that one of the government's primary reasons for launching the initiative is to be able to meet the latest corporate average fuel economy standards, which require cars to have fuel efficiencies of 54.5 miles per gallon by 2025. DOE research shows that a 10% drop in vehicle mass can reduce fuel consumption by 6–8%. Using highly engineered carbon-fiber composites could yield mass reductions of 60–70% in optimized vehicle structures.

Manufacturing reinforced polymer composites is energy-intensive and requires high temperatures and pressures to bond the different materials together. Carbon and glass fibers are produced using costly, high-temperature processes that yield small quantities. "So there will be a major focus on taking energy out of the carbon fiber manufacturing," Blue said. "There's also a need for high-volume carbon fiber and glass fiber manufacturing. We want to increase production speeds and cycle times."

Researchers will investigate ways to lower the cost of the

Advanced composites could make cars of the future lightweight and energy efficient. Photo courtesy of Ford Motor Company.

https://doi.org/10.1557/mrs.2015.127 Published online by Cambridge University Press

polymer precursors and to improve conversion and compositing technologies such as compression molding, high-pressure resin transfer molding, and insert/overmold injection molding.

At the other end of the life cycle, composites are currently recycled in limited quantities. "One challenge is to take the material back to a clean enough state so that it can be reused," said Kelly Visconti, a technical manager at the DOE Advanced Manufacturing Office. The polymer matrix and fiber have to be separated for the fiber to be reused, and this is currently done using heat, which can damage the fiber. "Composites are essentially long fibers with glue sticking them together," she said. "The trick is to remove enough polymer without damaging the fiber. We're looking for new ways to do that."

The IACMI will also have a heavy focus on modeling and simulation "to make sure we understand the properties that are really needed for an application," Blue said. Aerospace parts, for example, require composites with more than double the tensile strength and elastic modulus than auto parts need. So it might be possible to make car parts using lower temperature processes that result in less-enhanced materials properties. "The key thing in automobile is don't pay for properties that you don't need," he said.

Developing new lightweight composites for automobiles will require a multi-material solution, Blue said. So scientists will look at a combination of carbon-fiber and glass-fiber-reinforced composites, but also at metals such as manganese and aluminum.

In addition to materials research, the IACMI should help to advance technical education and to train a skilled manufacturing workforce for supporting the anticipated growth in advanced composites across the country. Over the next 10 years, more than 30,000 US manufacturing jobs could be created in the fiber-reinforced polymer industry, the IACMI estimates.

The IACMI is the fifth institute to be selected in President Barack Obama's National Network for Manufacturing Innovation (NNMI). The NNMI, first announced by the White House in January 2013, is intended to launch regional hubs that will boost advanced manufacturing, foster US innovation, and create jobs. The four institutes launched to date focus on additive manufacturing, wide-bandgap semiconductors, lightweight technology, and integrated digital design and manufacturing.

Prachi Patel

Spintronics research in Singapore gets a boost with new funding
www.nrf.gov.sg

Many mobile phone users complain about having a short battery life, which requires them to recharge the battery on a daily basis. This is because a battery needs to "feed" billions of energy-hungry, tiny electronic components within the phone—even when the user is not operating the phone. In the not-so-distant future, mobile phone batteries may be able to last weeks or longer, due to latest research in spintronics.

Spintronics is an emerging area that holds great potential for creating the next generation of electronic devices. The National Research Foundation (NRF), Prime Minister's Office, Singapore, announced in April a new fund of S$5 million, to support industry collaborations with Institutes of Higher Learning in developing new applications through spintronics research.

"Spintronics research focuses on creating 'normally-off' devices for 'always-on' applications. Computers are like humans, having to constantly access memory when making decisions. When users demand higher performance, it creates more traffic between the command center and the memory unit. In addition to making the memory nonvolatile, spintronics research could help to significantly shorten the distance of this information highway, making it faster and more energy efficient. It could also lead to completely new logic devices that have brain-inspired computing applications," said Wu Yihong, a professor in the Department of Electrical and Computer Engineering, Faculty of Engineering at the National University of Singapore (NUS).

Wu heads the Singapore Spintronics Consortium (SG-SPIN), which was set up last year by NUS and Nanyang Technological University (NTU) and supported by the NRF, to spur collaborative research partnerships between industry and Institutes of Higher Learning in the area of spintronics.

SG-SPIN has already initiated collaborations with industry on a number of spintronics research projects. This includes research to increase the speed and capacity of data storage in computers, improve energy efficiency in electronic gadgets, and develop new ultralow powered devices.

"Building on the [S]$39 million for on-going research work by SG-SPIN members, the National Research Foundation has allocated a further [S]$5 million to support SG-SPIN joint industry research collaboration projects. These funds will help to bridge the gap from research to industry application and grow the spintronics ecosystem in Singapore," said Low Teck Seng, CEO of NRF Singapore.

"We appreciate NUS' effort in taking the lead to drive spintronics technology as it enables SG-SPIN consortium members to learn more from the marketplace and to study the feasibility of any potential new applications that will benefit the industry members' customers," said Rajesh Nair, Vice President, Technology Development, at GLOBALFOUNDRIES, which is a co-founder of SG-SPIN. "It is important for GLOBALFOUNDRIES to be at the forefront of technology innovation to research and develop competitive and viable solutions for our customers since we serve all the key growth markets including computing, mobility, automotive, and industrial segments." □

https://doi.org/10.1557/mrs.2015.127 Published online by Cambridge University Press