Advanced materials manufacturing gets a government-backed boost

http://www.ncsu.edu/power/
http://almmii.org/

Two new materials-focused manufacturing institutes have recently been established giving high-tech materials manufacturing in the United States a significant boost. The Next Generation Power Electronics Manufacturing Innovation Institute and the American Lightweight Materials Manufacturing Innovation Institute (ALMMII) will serve as regional hubs focused on developing manufacturing industries around promising research technologies. Advanced manufacturing in the United States has been an area of focus for the Obama Administration, and in his 2013 State of the Union address, the President proposed the establishment of these institutes—as well as other advanced manufacturing institutes—using existing federal funds.

Over the next five years, each of the new manufacturing institutes will receive $70 million from the federal government to be matched by state, university, and industry funds. But in addition to providing the seed funding, the federal government "acted as a catalyst for the formation of the institutes," said Alan Taub, Engineering Professor at University of Michigan and Chief Technology Officer for ALMMII. Taub said that the institutes are "designed to bridge the gap between basic research and commercialization, which required building a team of world-class experts from universities, federal labs, and industry."

Announced in January 2014 and led by North Carolina State University (NCSU) and the Department of Energy, the Next Generation Power Electronics Manufacturing Innovation Institute is focused on wide-bandgap semiconductor (WBGS) technologies. Semiconductors are crucial for converting power to us able energy in devices such as cell phones and laptops, in industrial motors like those used in manufacturing, and in grid-connected power substations. Today's power electronics are dominated by silicon semiconductors, which are inexpensive but lose power during transitions to heat. WBGS devices—often made from silicon carbide or gallium nitride—can reduce the wasted power by up to 90%. Since less power is lost to heat, WBGS devices can utilize a smaller heat sink that reduces the size and cost of the device. Overall, WBGS devices are smaller, faster, and more efficient than silicon-based devices.

Despite the sound technological advantages of WBGSs, they have not yet had a significant market impact because the cost for WBGS devices can exceed five times the cost of commonly used silicon devices. Jay Baliga, NCSU Distinguished University Professor, has been working on WBGSs for power electronics for over 30 years—he pioneered WBGS research and produced the first SiC high-performance devices. Baliga said that the next hurdle for WBGS devices is the transition from the laboratory into the commercial arena, and he characterized the disparity in cost between silicon and wide-bandgap semiconductors as "the biggest challenge today for WBGS technology for power electronics."

Developing new manufacturing routes to close the cost gap between silicon and WBGS devices is the main goal of the power electronics institute. WBGS technology has already been proven, hence all research tasks funded by the power electronics institute must be directly tied to this manufacturing goal. A second goal of the institute is to "encourage the manufacturing of WBGS-based power electronics technology in the [United States] to create high tech jobs," said Baliga. These jobs cover a wide range of skills from engineering, to design, to manufacturing, and even more jobs will be added when WBGS foundries are established for the first time in the country (foundries are currently planned to be located in Texas, New Jersey, and North Carolina).

Adding jobs and strengthening the regional economy is also a focus of the American Lightweight Materials Manufacturing Innovation Institute, which was announced in February 2014. Led by EWI (an advanced manufacturing nonprofit), the University of Michigan, The Ohio State University, and the Department of Defense, the lightweight materials institute is headquartered in southeast Michigan and is expected to enable 10,000 new jobs for the region as lightweight and modern metals manufacturing ramps up over the next five years. According to Taub, the new manufacturing industry will require "development of a world-class manufacturing workforce." Taub said, "The partnership between universities and industry through the institute will provide the opportunity for students and workers to get the necessary education and training."

The lightweight materials institute will tackle scaling and commercialization challenges to bring advanced high-strength steels, titanium, aluminum, and magnesium alloys to the transportation sector. The lightweight materials institute is focused on land, sea, and air transportation, but these materials can be used across many sectors. Utilizing stronger and lighter materials in both commercial and defense transportation applications can improve performance, safety, and efficiency. One of the most obvious advantages of deploying high-strength and lightweight metals in transportation is reducing the overall vehicle weight without sacrificing safety and reliability, which can lead to significant fuel savings.

A number of these lightweight materials have already been developed and demonstrated to possess the necessary proprieties at the laboratory scale. Research activities funded by the lightweight materials institute must

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therefore focus on developing a robust manufacturing process to produce reliable and cost-competitive products. While specific projects have not yet been defined, Taub said, "Priorities will be set by finding common challenges that can be addressed across at least two sectors—land, sea, and air transportation—and since projects are industry-driven they are therefore very relevant for commercialization."

These two new materials-focused manufacturing institutes are part of a larger initiative to establish a full national network of up to 45 manufacturing institutes in the United States. The National Network for Manufacturing Innovation (NNMI) launched its pilot institute in Youngstown, Ohio, in 2012. This first institute, called the Additive Manufacturing Innovation Institute but rebranded as America Makes in October 2013, is focused on additive manufacturing, which includes three-dimensional printing. A fourth manufacturing institute, the Digital Manufacturing and Design Innovation Institute, to be headquartered in Chicago, Ill.,was also announced in February 2014.

In addition to the first four institutes, President Obama has announced a new competition for an Advanced Composites Manufacturing Innovation Institute and plans to announce three more manufacturing institute competitions over 2014. While the Obama Administration has utilized existing funds to establish the initial four manufacturing institutes, significant further expansion of the network will require congressional action. A bipartisan bill that would create a manufacturing network consistent with the NNMI and led by the Department of Commerce was introduced in both the Senate and the House in the US Congress in July 2013, but has not yet been taken up by either chamber.

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South Africa may be ending its downward trend in R&D investment

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While the gross expenditure on research and development (GERD) in South Africa had been in decline since 2006, the latest R&D survey shows what may be a reversal in this trend. For two years in a row, R&D investment maintained the level of GERD at 0.76% of the gross domestic product (GDP). The latest report captures numbers from 2011/2012.

"We anticipate that we are turning the corner and starting to increase the level of investment in R&D once again in South Africa," said Derek Hanekom, Minister of Science and Technology.

The National Development Plan (NDP) calls for greater investment in R&D, combined with efforts to make better use of existing resources, the development of more institutions that facilitate innovation, and enhanced cooperation between public science and technology institutions and the private sector. In response to the NDP's call for greater investment in R&D, government has included an ambitious target of achieving an increase in R&D investment to 1.5% of GDP by 2019.

The largest percentage of GERD—at 17.2% in 2011/2012—is in the medical and health sciences, showing a steady increase year by year. Materials science received 0.7% of the GERD, which is up slightly from 2010/2011, yet still far below the 1.2% of GERD it received in 2009/2010.

According to the survey, South Africa's R&D intensity of 0.76% was below the world average GERD/GDP ratio of 1.77%. For 2011/2012, Israel is the highest with GERD as a percentage of GDP at 4.80%; then Finland at 3.78%, and Japan at 3.39%. In comparison to the five major emerging national economies, South Africa R&D intensity falls below 1%, while the others are above 1% (excluding India).

The R&D survey is conducted annually in South Africa by the Centre for Science, Technology and Innovation Indicators (CeSTII) on behalf of the Department of Science and Technology (DST). In addition to R&D investment levels, the survey also generates insights into R&D personnel trends in South Africa. From 2010/2011 to 2011/2012, personnel increased by 7%. According to DST, South Africa will need to maintain this level of increase if it is to take advantage of the knowledge economy.

The Director-General of DST, Phil Mjwara, said that greater effort is required from the private sector. Through interventions like the R&D tax incentives, direct government grants for R&D, and R&D partnerships, government is contributing significantly to supporting business. However, as government increases its level of investment, a similar level of increased R&D investment by the private sector is needed. Over the next few years, the DST plans to enhance its level of interaction with the private sector to achieve the R&D investment targets. □

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