A funding boost for materials research in Germany

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Materials scientists and engineers in Germany can look forward to a healthy injection of funding following the launch of a government program to help stimulate product development using new materials. Germany's Federal Ministry of Education and Research (BMBF) notes that materials can account for almost half of production costs in the manufacturing industry. And since making innovative materials is slow and expensive (development cycles of 10 to 15 years are not uncommon), the German government is keen to give the process a helping hand. This new program, named "From Material to Innovation," will run for a decade, providing researchers with about €100 million a year.

According to Herbert Zeisel, Deputy Director-General for Key Technologies for Growth at the BMBF, the program aims to strengthen Germany's competitiveness and establish materials expertise in German industry. According to BMBF, around 5 million people in the country work in materials-based industries. "The aim is to involve small- and medium-sized enterprises in the innovation process even more heavily than in the past and to train young research talent," says Zeisel.

He says that they are looking particularly to major fields such as energy, transport, medicine, and construction. Each year the ministry will announce more detailed themes on which each round of funding will be focused. The program will be administered by Project Management Jülich.

This program is part of Germany's High-Tech Strategy, aimed at making the country a global leader in innovation, and the wider *Industrie 4.0*, or fourth industrial revolution, which is based around smart factories. It replaces a similar materials initiative that ran in the 10 years leading up to 2014, with €900 million. Funding like this is particularly important in Germany, where commodities tend to be expensive, putting extra pressure on firms to reduce their resource consumption.

More than two-thirds of the companies that received funding under the government's previous materials research program reported that their ideas had either been or were about to be commercialized. Projects included a ship's fin made of adaptive fiber-composite materials, which was particularly useful on high seas, and reduced fuel consumption. Another success story was a drill bit made of ultrahigh performance concrete, which improved the speed and cost of driving foundation piles.

Kerstin Schierle-Arndt, a research manager in inorganic materials, and Markus Müller-Neumann, a manager for European innovation policies, both at BASF, agree that government funding in materials development has been a success. They cite in particular its help in developing battery materials for electric vehicles. "Research in electrochemistry and on batteries did not receive much attention in the late 1990s and early 2000s. As a consequence we lacked talent in electromobility. The funding policy over the last five years helped to develop a renewed vibrant electrochemistry scene in Germany," says Schierle-Arndt.

Sanjay Mathur, Director of the Institute of Inorganic and Materials Chemistry at the University of Cologne, was among the researchers to benefit from BMBF funding to develop better lithium-ion batteries. He and his team found that they could develop new electrode architectures with high energy densities and less weight by using nanofiber-meshes of lithium iron phosphate. "The BMBF funding and programs are more crucial than ever," he says.

According to Ferdi Schüth, Director of the Max Planck Institute for Coal Research, the energy sector could particularly benefit from more funding, given Germany's ongoing transition to a renewables-based economy, known as the *Energiewende* (see *MRS Bulletin*, September 2014 issue). Areas with development potential include photovoltaics, materials for heat storage, and materials that can cope with fluctuating loads.

Schüth says that Germany's High-Tech Strategy has been a good mechanism for bringing people together to discuss how science can be used for Germany's economic development. "The political agenda is to have basic academic research translated into

Catalyst materials for the chemical industry (courtesy of BASF SE).

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products," he says. However, he also notes that "we have a very good system in Germany for getting companies going with seed money… but conditions are worse than the US [United States] for venture capital funding."

Traditionally, European researchers have also been slower to commercialize their work than scientists in the United States. "University research in Germany is to some extent more fundamental, while in the US it is more application-driven," says Schierle-Arndt. By encouraging closer collaboration through funding streams like this latest one, the German government hopes to change that.

"I hope that it will also strengthen material science at universities in general," says Claudia Felser from the Max Planck Institute for Chemical Physics of Solids in Dresden. She observes that technical universities are the ones that tend to have materials science departments in Germany, but that there is much to be gained from the work of physicists and chemists, too. "A truly interdisciplinary approach will help to close the gap between classical materials science and modern materials science—in areas such as nanoscience, materials for modern electronics, and quantum materials—which will play a role in the future," she says.

The German government has been actively supporting materials science and engineering since the 1970s. "They have been quite successful over the years, but this is hard to measure," says Oliver Kraft from the Karlsruhe Institute of Technology and the 2015 President of the Materials Research Society. "Overall, the German economy is doing well based on mechanical, chemical, and electrical engineering, all being supported by progress in materials. So, I would state that the long-term effort has really helped to establish materials science and engineering as a key technology in Germany."

Angela Saini

NASA's MaterialsLab improves how research is conducted on Earth and in space www.nasa.gov

When companies try to "build a better mousetrap," the process can involve a lot of internal studies and tests on the kinds of materials to use and effective designs. It can be a time-consuming but necessary operation, which means less time for people to use the device to solve a particular problem.

NASA and the National Institute of Standards and Technology (NIST) are collaborating to help scientists and innovators build that new mousetrap by accelerating materials development, and make new discoveries using data from the hundreds of investigations on the International Space Station.

An initiative between the two government agencies has created MaterialsLab—a new approach to materials science research that will provide unprecedented worldwide collaboration. Each space station investigation provides scientists with a better understanding of the physical and chemical properties of materials, allowing insight on how they develop and behave without gravity affecting the results. The MaterialsLab approach enhances the way researchers in government, industry, and academia develop investigations and share information.

"We're creating a new opportunity to develop materials experiments in space that makes it easier for scientists to conduct these investigations and share their research and data widely with the scientific community," said Marshall Porterfield, NASA's Director of Space Life and Physical Sciences in the agency's Human Exploration and Operations Mission Directorate at NASA Headquarters in Washington, DC. "The Open Science concept allows multiple researchers around the world ... to access data from station experiments and build on each other's work."

NASA and NIST recently signed a Memorandum of Understanding to foster collaboration among NASA's microgravity materials science program, the NIST Material Measurement Laboratory, and the multi-agency Materials Genome Initiative.

MaterialsLab will share data from past and present space station investigations through NASA's Physical Science Informatics system—a resource for processing and sorting data from physical science experiments performed aboard the orbiting laboratory. The goal is to promote an open-access approach to scientific data analysis and potentially guide hundreds of new, station-based scientific investigations.

With MaterialsLab, NASA is changing the way scientists conduct research by adding a slight twist. Now, space station materials research will aim to solve engineering problems that not only relate to space travel, but also target a specific outcome or attack a materials problem identified by industry.

"We want to conduct new investigations that fulfill a specific industry need or could lead to a new commercial application," said John Vickers, the manager of the National Center for Advanced Manufacturing at NASA's Marshall Space Flight Center in Huntsville, Ala. "If the automobile industry is having a problem with a specific material, we may be able to study that material on the station and get an answer that they couldn't obtain through ground-based research. We are not only learning about the material, but also providing valuable data that immediately affects companies and consumers on Earth."

Through MaterialsLab, NASA is changing the way scientists share data and even their approach to proposing experiments. "It should be easy for investigators to access current data from experiments and use it to determine if there are gaps in knowledge that can be addressed with new investigations," Porterfield said.

NASA leaders want to continue scientific experiments to learn more about the world and the universe. They also want to change the way research is conducted by fostering a spirit of collaboration to share results from investigations on the orbiting laboratory as soon as possible. □

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