# Inventions Inspired by Nature

Inspired by the extraordinary properties found in natural processes, 2013 Lemelson-MIT Prize recipient Angela Belcher, Ph.D., creates new, organic-inorganic materials that can be used to manufacture sustainable electronic devices, fuels, and other inventions that benefit business, society, and the environment.

By Meredith Holmes, SWE Contributor

Angela Belcher, Ph.D., a materials chemist and one of the world's leading scientists working in the field of nanotechnology, is the 2013 recipient of the Lemelson-MIT Prize. The honor comes with an award of $500,000 and recognizes an especially gifted, midcareer inventor dedicated to improving the world through technological inventions. The prize's namesake, Jerome H. Lemelson, was a prolific American inventor. In 1994, his wife, Dorothy Lemelson, who chairs The Lemelson Foundation, established the Lemelson-MIT Program. Dr. Belcher is the second woman to be honored with the top prize since the award's inception nearly 20 years ago.

Dr. Belcher is the W.M. Keck Professor of Energy in Materials Science and Engineering and Biological Engineering at the Massachusetts Institute of Technology. She is also on the faculty of the David H. Koch Institute for Integrative Cancer Research. Her areas of expertise and her research interests span inorganic and materials chemistry, biochemistry, molecular biology, and electrical engineering. She has developed hybrid, organic-inorganic materials with wide-ranging applications: environmentally friendly batteries, clean transportation fuel, solar cells, transparent conductors, and detection of very small tumors, particularly ovarian cancer.

## Pursuing a fundamental question

All of Dr. Belcher's inventions have sprung from the question she asked herself while doing her Ph.D. research on how abalone sea snails grow their shells: How does nature make materials? "Abalone shells are a fascinating composite," she said. "By mass they are 98 percent calcium carbonate and 2 percent organic proteins. They are strong and tough and they are manufactured in the ocean … using nontoxic materials. And, most interesting to me, they do not add toxins into the environment. How do they do that?"

Angela Belcher, recipient of the 2013 Lemelson-MIT Prize.

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She knew that, as in diatoms and even in human bones, the abalone shell's proteins are coded at the genetic level to sculpt the composite material. Reasoning that this process could be adopted to create new, technologically useful materials with the same extraordinary properties found in nature, she focused on finding proteins that could recognize and grow new material. "The key was to beat 50 million years of evolution. It took abalone shells a long time to get really good," she said. To solve this problem, she turned to bacteriophages — simple viruses with single-stranded DNA that infect specific bacteria, but are benign to humans. She invented a process that used Phage Display libraries — huge collections of genetic data — to find the viruses that can identify inorganic materials. She then altered these select viruses by exposing them to elements in the periodic table. This speeded-up evolution has led the way to development of materials that can be used to manufacture sustainable electronic devices and fuels.

"People said I was crazy when I proposed this," said Dr. Belcher. "But it's not crazy; that's what nature does. It has proteins that can recognize one crystal structure versus another and grow one mineral versus another." She didn't expect that the technique she devised to find these proteins would be such a versatile invention. "When I started, I had no interest in using the virus itself," she said. " … but the virus is crystalline, and if you take advantage of the proteins on the coat of the virus, they can act as nucleation sites for the growth of materials."

Dr. Belcher cofounded two companies, Siluria Technologies and Cambrios Technologies. Siluria Technologies uses engineered viruses and catalysts to create new routes to cleaner fuels and chemicals for manufacturing by developing a process to economically convert methane to ethylene. Cambrios Technol-

ogies is an electronic materials company that has developed a new bio-inspired ink (ClearOhm™) composed of transparent conducting nanowires that make the surface it coats touch-sensitive.

A native of San Antonio, Texas, Dr. Belcher earned her B.A. from the College of Creative Studies at the University of California, Santa Barbara (UCSB) in 1991. Students in this program design their own curricula, and hers combined chemistry, biology, physics, and ecology. "Having this kind of freedom as an undergraduate was huge for me," Dr. Belcher said. "It allowed me to pursue what I was most interested in, and it taught me that things could be put together in different ways. It set the template for grad school and for how I approach my work in my current lab." She completed her Ph.D. in inorganic chemistry at UCSB in 1997 and worked there as a postdoctoral fellow. She was assistant professor in the chemistry and biochemistry departments at the University of Texas at Austin from 1999 to 2002. She joined MIT in 2002.

Among the numerous honors, awards, and fellowships Dr. Belcher has received are: the Boston Museum of Science Walker Prize in 2012; Scientific American's Researcher of the Year award in 2006; finalist for Innovator of the Year in nanoscience in 2005; a MacArthur Fellowship award in 2004; named one of 12 women at the forefront of chemistry by Chemical and Engineering News in 2002; the Wilson Prize in chemistry from Harvard University in 2001; and a Beckman Young Investigator Award in 1999.

"Angela Belcher is an extraordinary inventor," said Joshua Schuler, executive director of the Lemelson-MIT program. "She has taken a single idea and applied it to develop a remarkable portfolio of inventions that will benefit business, society, and the environment. Most impressive, Angela never fails to remember the immense value of youth mentorship and its ability to inspire the next generation of inventors."

As an undergraduate, Dr. Belcher helped set up the Equal Opportunity Program in Science and was active in mentoring and outreach at the University of Texas. She speaks widely to students about science and hosts her own Chemistry Circuses for elementary school students, including her own children.

"I feel very lucky that I have these opportunities to get kids excited about science," she said. "To me science is like play — it's a blast, and I think when kids sense they're being taught by someone with a real passion for the subject, it's infectious. I just know I've never had a kid say, 'No, I don't want to make a nanowire.'"

*To view video of the event, please go to: http://www.nbm.org/media/video/society-of-women-engineers.html.*

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# North American Gender Summit Convenes in November

When international researchers gather this fall, they will share their recent work that exhibits how including gender considerations improves research outcomes. Creating an action plan to engage and integrate women and women of color into STEM development, research, and innovation worldwide will be a top priority.

By Sandra Guy, SWE Contributor

A team from government, academia, and societies, including the Society of Women Engineers, has designed a groundbreaking meeting of engineers, scientists, and policymakers to advance innovation through gender equality in North America.

The third in a series, Gender Summit 3, will meet for the first time in North America Nov. 13-15 at the Washington Hilton Hotel in Washington, D.C., with more than 800 attendees expected — participation rates that previous Gender Summits in Europe have enjoyed.

SWE Executive Director Betty Shanahan, CAE, F.SWE, has worked closely with summit leaders to ensure that women throughout North America gain