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Shell shock

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Angela Belcher, professor of materials science and engineering. Photo / Donna Coveney

An MIT materials scientist's research on sea snails has helped transform battery technology and may end the era when cell phones die if they're dropped and PDAs must be replaced if they get dunked in the tub.

Thanks to those sea snails and a eureka moment, Angela Belcher, Germeshausen Professor of Materials Science and Engineering and Biological Engineering, is developing smart nano-materials--hybrids of organic and inorganic components--beginning with a rechargeable, biologically based battery that looks like plastic food wrap.

Belcher's eureka moment occurred 10 years ago; it arose from her long, delighted fascination with abalone, the sea snail, and from her willingness to ask a wide-open question, "What if?"

Holding up an abalone shell before a visitor, Belcher describes the moment when the two threads--persistent interest and sudden insight--came together, forming the basis of her current research, which spans inorganic chemistry, materials chemistry, biochemistry, molecular biology and electrical engineering.

A seventh-generation Texan, Belcher began studying abalone when she entered the University of California, Santa Barbara, as a graduate student. (Abalone cling to California's coastal rocks.) Intrigued since childhood by pearls and pearl-making mollusks, she was impressed by the abalone's shell: it's 98 percent calcium carbonate--what we call chalk, only 3,000 times stronger.

"The abalone makes this amazing material out of a common mineral," she says.

As a doctoral student at Santa Barbara, Belcher had an office with an ocean view. Working on her dissertation, a study of how the abalone produces both its rough outer shell and its opalescent interior simultaneously, she could see whales and dolphins in the Pacific.

On the wall opposite her desk hung a huge periodic table.

"Suddenly, I wondered, what if we could assemble materials like the abalone does--but not be limited to one element? What if we could bond protein to other elements in the periodic table and grow new materials?" she says.

Belcher recalls she stood on her desk to get closer to the chart of 110 elements, and that she felt like running down the hall in excitement.

"It seemed so logical and easy. Shells had been self-assembling, manufacturing amazing materials for 500 million years," she says.

Belcher received her PhD in 1997 and came to MIT in 2002. She won a MacArthur "Genius" award in 2004 and was named Researcher of the Year by Scientific American in 2006.

Her eureka moment has launched a new chapter in bio-engineering; it has led to the development of smart new nano-materials, essential to advances in optics and electronics.

With MIT colleagues Paula Hammond, Bayer Professor of Chemical Engineering, and Yet-Ming Chiang, professor of materials science and engineering, Belcher grew the first biologically based, nano-scale rechargeable battery--the one that may end short-lived cell phones.

Belcher's MIT battery is comprised of a virus she and her colleagues engineered to latch itself to cobalt oxide. It does look like a clear film. Transparent, efficient, it could one day be poured onto the object it's powering, like a coat of energizing paint.

Fabricating viral films, Belcher says, may provide new pathways for organizing molecules to help create electronic, optical and magnetic materials.

And she keeps studying the ancient abalone for clues to those new pathways. She keeps a cache of abalone shells on her MIT desk.

"It builds exquisite materials. It's a very nice animal, " vegetarian Belcher notes, offering a shell to a guest.

(In her research, Belcher is careful to avoid harming or killing her subjects, who live in abalone condominiums. To get samples of their secretions to study, she inserts glass slides beneath their shells, rather than endanger them.)

Belcher still enjoys heady moments like the one in her oceanfront office, when delight makes her feel like running down the hall outside her lab in Building 16.

But her work at MIT is driven by a different question than the one that arose when she stood on her desk, scanning the periodic table, abalone shell in hand.

"Back then, I asked, 'What if? Wouldn't it be interesting if?'" she says. "Now, the questions are more like, 'What's the most efficient, useful material we could make?'"

Ultra-tiny computer chips, fuel cells, "smart" nanocrystal sensors--anything is possible with hybrid materials, she says.

"Abalone shells are self-assembling. What if we could make a material that is self-re-assembling? What if iPods and Blackberrys could genetically mend their own cracks? These devices get dropped; they break; what material can we make so they fix themselves?"

Source: MIT

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