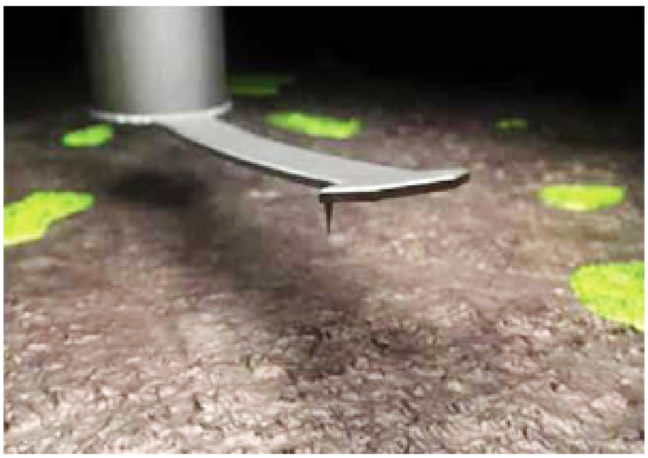
Tiny invention may harness big energy from small spores

January 30 2013, by Beth Kwon



An illustration of part of Professor Ozgur Sahin's atomic force microscope, which measures mechanical forces at the molecular level. Seen here is the sharp silicon tip of the device, which scans an object's surface and bends in response to force.

(Phys.org)—One of Ozgur Sahin's first machines was a mechanical adding device made from Legos. He made it when he was 11 and hasn't stopped making gadgets since. In graduate school Sahin created an atomic force microscope that could measure mechanical forces at the molecular level, winning the grand prize in the National Inventors Hall of Fame's Collegiate Inventors Competition.

Today a refined version of the microscope is Sahin's primary research tool. With it the associate professor of biological sciences and physics is able to study substances on the nanoscale, with implications ranging from health and disease prevention to alternative energy.

"Scientists are always working on making better microscopes to see smaller and smaller things, but what my lab wants to do is to identify not only the shapes and locations of objects but what their physical properties are," Sahin explains.

His version consists of a cantilever with a sharp silicon tip that acts like a fingertip to scan an object's surface and bends in response to force. Sahin compares the process to catching fish. For example, if he puts a snippet of DNA on the needle as bait, when it comes across a matching molecular sequence, it will respond with a certain force.

Anything that combines, from amino acids to DNA, generates force, which is what he sets out to measure. The cantilever measures it via the twisting, bending and binding of the target molecule. "We rely on forces and how they change," Sahin says. "The end result is really simple but there are so many things going on. It's classical physics."

A growing area of research in his Northwest Corner Building nanoscience lab is understanding bacterial spores. Sahin was curious about Bacillus, a type of bacteria commonly found in the soil. Spores of Bacillus have accordion-like wrinkles. In humid conditions the spores absorb moisture from the air, and the wrinkles unfold and change up to 40 percent in volume.

"The biggest power source in nature is evaporation," said Sahin. "Our climate is powered by evaporating water from the oceans, and we have no way of accessing this energy. We can access wind power but not evaporation. This may be an opening for a completely new energy platform."

All motion takes energy. Considering how much the spores change, Sahin figured he could harness the motion and convert it to energy. "We noticed that expanding and contracting spores can act like a muscle, pushing and pulling other objects," Sahin explains.

In the Nov. 7, 2012 edition of the *Journal of the Royal Society*, Sahin published his findings about how the wrinkles emerge and why—it is a survival mechanism to protect the spores' genetic material. The U.S. Department of Energy is supporting further research to study the force from the unfolding wrinkles and to build new types of materials by assembling the spores into larger structures. The work may eventually lead to the development of a battery that can use energy from spores.

One possible application is an industrial coating made of spores that can be painted onto a flexible, rubbery material, which would curve in response to the level of humidity. Sahin compares the potential output to solar power.

Sahin was encouraged early on to cultivate such creative thinking by his father, a surgeon, and mother, a teacher. He grew up near Ankara, Turkey, and in high school was one of five students chosen to represent his country in the International Physics Olympiad.

After attending college at Bilkent University, he moved to the U.S. in 2001, earning his master's and Ph.D. at Stanford. Sahin was a Rowland Junior Fellow at Harvard for several years before coming to Columbia in 2011. "My parents emphasized the importance of learning new things," Sahin says. "I always had the mindset that I could make and create things myself."

Provided by Columbia University