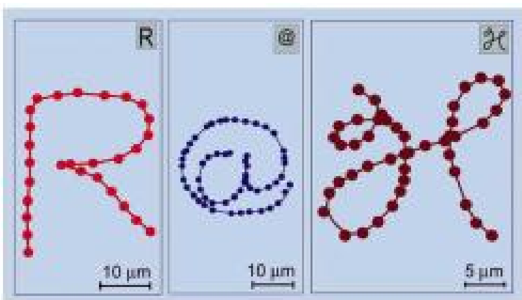
Spiral swimmers may prove micro workhorses (w/Video)

May 11 2009



Researchers Ambarish Ghosh (left) and Peer Fischer of the Rowland Institute at Harvard have devised a new microscopic swimmer, a corkscrew that rotates in a magnetic field.

(PhysOrg.com) -- Harvard researchers have created a new type of microscopic swimmer: a magnetized spiral that corkscrews through liquids and is able to deliver chemicals and push loads larger than itself.

Though other researchers have created similar devices in the past, Peer Fischer, a junior fellow at the Rowland Institute at Harvard, said the new nano-robot is the only swimmer that can be precisely controlled in solution.

At just two microns long and 200 to 300 nanometers wide, the corkscrew swimmer is about the size of a bacterial cell. The work was published online May 4 in the journal Nano Letters. Fischer and

Rowland Institute postdoctoral research associate Ambarish Ghosh were able to control the tiny device well enough to use it to write “R @ H” for “Rowland at Harvard” within a space that’s less than the width of a human hair.

Further, they were able to use it to push a 5 micron bead — which had a volume more than 1,000 times that of the swimmer — and were also able to control two of the swimmers simultaneously.

“It really has good control. It’s exactly doing what we want it to do,” Fischer said.

The Rowland Institute was created by legendary Polaroid founder Edwin Land in 1980 as the Rowland Institute for Science, a nonprofit, basic research laboratory. It maintained its scientific mission in 2002, when it merged with Harvard and became the Rowland Institute at Harvard.

Fischer said the strength of his and Ghosh’s work is not just the swimmer’s performance but also its manufacturing method, which allows many swimmers to be created simultaneously.

The devices are made by exposing a silicon wafer to silicon dioxide vapor. The wafer is slowly rotated as the vapor condenses, growing the devices in a corkscrew shape. They are then shaken loose, sprayed with cobalt, and magnetized. Because they are lying on their sides when the cobalt is applied, the process provides a magnetic “handle” to rotate the corkscrews with.

“You can make hundreds of millions in a square centimeter,” Fischer said. “Even if you use only a few percent, that’s still a lot. … You can make a lot of them very quickly.”

Fischer and Ghosh took one last step, which didn’t improve the swimmers' functionality, but allowed them to be tracked: they coated them with a fluorescent chemical.

Once complete, the researchers surrounded the swimmers with three magnetic coils, allowing them to precisely adjust the magnetic field, and control the tiny devices in three dimensions.

The microscopic world of the nano-swimmer is different from the one we experience when going for a swim, Fischer said. Because it operates at such a tiny scale, water that we move through relatively easily — thin and runny - appears thicker to the nano-swimmers, more like honey. The swimmers meet a considerable amount of resistance to their forward motion so that they really need to drill their way forward, he said.

The devices move at about the speed of bacteria, 40 micrometers — one micrometer is a millionth of a meter — per second.

Though applications in drug delivery, microsurgery, and other aspects of medicine seem apparent, Fischer said it's too early to speak about those realistically.

However, Fischer said the artificial swimmers can be used to test some of these ideas and could have almost immediate applications in research, being used to shuttle chemicals in and out of cells or testing the strength and properties of membranes, for example.

More information: pubs.acs.org/doi/abs/10.1021/nl900186w

Provided by Harvard University (news : web)