Researchers Create Tiny, Self-Propelled Devices

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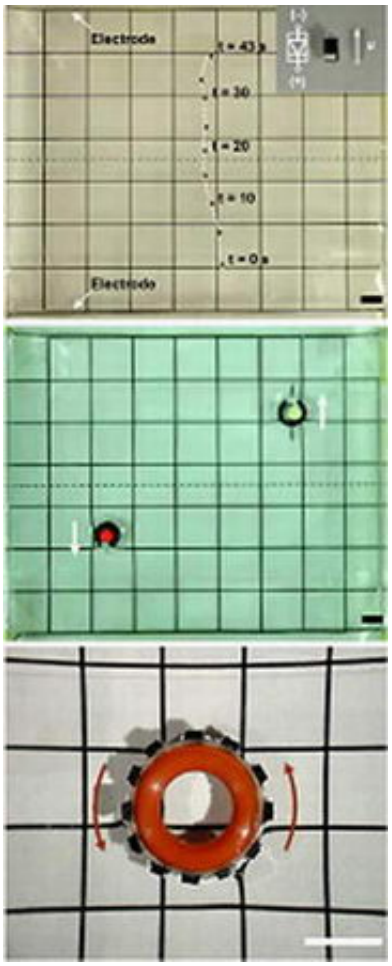
North Carolina State University scientists have figured out a method to supply microscopic devices with enough energy to not only allow them to propel themselves through liquid – a difficult function in its own right – but also to perform some other functions, like emitting light.

The findings have the potential to lead to “smart devices” or “microrobots” that can interact with their environment and perform certain tasks – like moving, sensing other materials, including biological materials, lighting up and spinning – on their own.

The millimeter-sized devices can be controlled externally and have the potential to be powered by radio waves.

The research is published in the February 2007 edition of *Nature Materials*.



NC State&acutes tiny, self-propelling diodes move (top); move and light up (middle); and spin around (bottom) in liquid.

The researchers – Dr. Orlin Velev, associate professor of chemical and biomolecular engineering at NC State and principal investigator of the project, Suk Tai Chang, a graduate student at NC State and their colleagues Dr. Dimiter Petsev from the University of New Mexico and Dr. Vesselin Paunov from the University of Hull in the United Kingdom – took various types of millimeter-sized diodes, or electronic devices containing two electrodes, and placed them in a liquid-filled dish with two external electrodes placed on the outer edges of the dish.

The researchers applied alternating electric fields to the electrodes at the outer edges of the dish, which provided energy for the diodes to move on their own. The diodes absorb the external field energy and convert it into motion in a process called electro-osmosis.

“There are very few ways to make microdevices move around, especially in liquid, because as you scale down the size of the device, viscosity plays a more important role . It’s somewhat like swimming in molasses,” Velev said. “We have shown how to provide devices with external energy from electrical fields, which the devices convert into directional motion that can be controlled electronically.”

But the researchers’ self-propelling microdevices do more than just move through liquid. The paper describes how the voltage induced within the devices’ electrodes can be used to perform other functions, like emitting light or spinning around. Velev and his colleagues also controlled the speed at which some diodes move by directing a laser beam at the tiny devices, proving further that the devices can sense their environment and act in certain ways.

This sensing function could be very important, Velev says, if it can be used to separate biological molecules, such as looking for a particular protein and analyzing it. He also envisions future tiny devices that can move through biological fluids for applications like drug delivery or microsurgery.

Now that they’ve proven the concept, Velev and his team are working to create better microfluidic devices where the flow of microscopic volumes of liquid can be steered and controlled by electronic diode pumps, valves and mixers. Microfluidic devices with diode pumps can achieve better analysis of biological samples, assist in development of drugs or perform other biotechnology operations.

Citation: “Remotely Powered Self-Propelling Particles and Micropumps Based on Miniature Diodes”, Authors: Suk Tai Chang and Dr. Orlin D. Velev, NC State University; Vesselin N. Paunov, University of Hull; Dimiter N. Petsev, University of New Mexico, Published: Feb. 2007, in *Nature Materials*

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