Nano World: Twin-barreled nano-eyedropper

March 7 2006

Devices resembling crosses between eyedroppers and double-barreled shotguns only nanometers or billionths of a meter wide can create droplets 10 times smaller than a red blood cell for use as chemical reactors, experts told UPI's Nano World.

"This could open up enormous reductions in cost when it comes to experiments involving complex biochemical reactions, such as in the pharmaceutical industry," said David Klenerman, a chemist at the University of Cambridge in Britain. "You could screen a variety of different variants of a drug to find which one had the optimum effect on a protein you want to target, and just use extremely small droplets instead of larger volumes."

Scientists use eyedroppers or pipettes as routinely as they do test tubes in labs, to drain, inject or measure precise amounts of fluid. Klenerman and his colleagues are developing pipettes that can deliver just single molecules.

Their newest pipettes possess two barrels, each roughly 100 nanometers across, separated by a wall 25 nanometers thick. Each barrel also has an electrode inside. By giving one electrode a positive charge and the other a negative one, the researchers can drive a fluid within one barrel toward its tip. With a large enough voltage, the pipette expels droplets. Klenerman and his colleagues found they could very precisely control the size of the drops they create.

By applying a lower voltage, the researchers also found they could easily inject just molecules from the pipettes without increasing droplet size "to get biochemical reactions to take place," Klenerman said. Apparently, no mixing of contents between the two barrels occurs, since molecules seem unable to return into either barrel after they leave because of the electric fields involved, he added.

The researchers managed to use enzymes to create fluorescent proteins within droplets as a proof of principle. Klenerman and his colleagues reported their findings in the scientific journal Nano Letters.

In the future, Klenerman and his team want to attempt more complex designs, such as pipettes with eight barrels. Scientists could then load a number of different chemicals into each barrel for more complicated reactions.

One of the barrels within such a multi-barreled pipette could also serve as a microscopic probe, Klenerman added, to scan over surfaces much like fingers of a blind person running over a page of Braille. Such probes would not even need to actually touch any surfaces. Instead, researchers would suspend electrified probes over surfaces and obtain data about targets by measuring the interactions between the surfaces and ions flowing to and from the probe.

"We'd like to combine this with our work into imaging live cells," Klenerman said. "This could be used to deliver reagents to trigger a cellular response and then to monitor the cellular response to a given dosage, for instance."

One disadvantage of their current system is that pipettes can vary in size a bit when made. In the future, Klenerman hopes to better control the size of the manufactured pipettes. They also hope to create multiple pipettes that can act in parallel.

"It's very hard to create a controlled delivery system of chemicals," said chemist Richard Zare at Stanford University in California. "This will be an interesting device for many purposes. Hopefully this will become a standard tool."