Experimental Technique Sorts DNA, Cells, Molecules in a Split Second

October 17 2007

A simple device just a few millimeters across can separate microscopic objects such as DNA or cells in a fraction of a second—thousands of times faster than conventional methods.

University of Rochester researchers have patented the device, which they hope will make tests such as identifying proteins in a tiny sample of blood as simple as placing a drop on a handheld device. Laboratories and hospitals all over the world use similar, albeit cumbersome, hours-long processes in efforts to identify everything from DNA fragments to pathogens.

"We see this as a powerful technique for biochemical analysis. It's very quick and we can work with incredibly small sample sizes," says Michael King, associate professor of biomedical engineering. "This process can separate proteins, and in theory it can separate them even when they are the same size and have the same electric charge."

King and Thomas Jones, professor of electrical and computer engineering, induce an electrical field around the droplet to be analyzed, and in one-tenth of a second the droplet elongates along an electrode into an electrified, liquid string. As the fluid is stretched, the electrical field separates the molecules laterally along the edges of the long droplet. Stretching the droplet along a specially prepared detector can lay down one set of molecules directly onto the detector, making their recognition highly efficient, says King.

King and Jones found that a micro-liter of fluid or less is enough for the process to work with great efficiency. The most common method of separating proteins, called gel electrophoresis, requires more liquid and can take several hours, says King.

As outlined in Jones's 1995 book, *Electromechanics of Particles*, the frequency of an electric field can be tuned to send one subset of particles in one direction, and another set of particles in the reverse direction based on the way they behave in an electric field.

"We get a little droplet from a micropipette; all you have to do is load the thing," says Jones. "It's much simpler than other microfluidic schemes being used."

Jones had conducted research in microfluids and the dielectrophoretic force for decades when King suggested adding particles to the liquid experiments. They experimented with a variety of substrates and voltages, finally finding a coated electrode structure comprised of two parallel strips each thinner than a human hair. The strips allowed them the necessary control over the movement of the fluid and particles within. The discovery was first documented in 2005 in the *Journal of Applied Physics*.

The team is now looking into building electrodes with integrated particle detectors, and using fluorescence-marked proteins to see if they can increase the speed and accuracy of the process further yet.

Source: University of Rochester

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