Sandia’s dielectrophoresis device may revolutionize sample preparation

Researchers at Sandia National Laboratories in California have developed an enhancement to a well known “force phenomenon” called dielectrophoresis that they say could revolutionize the way biological sample preparation is conducted. Sandia is actively seeking commercial partners to help bring the technology to the marketplace.

Known as an insulator-based dielectrophoretic device (iDEP), the new tool developed at Sandia selectively — and very quickly — concentrates live pathogenic bacteria within large water samples. The technology development was internally funded through the Laboratory-Directed Research and Development (LDRD) program.

iDEP can deliver detectable amounts of material in small sample volumes, eliminating any need for overnight culturing and significantly speeding up water analysis.

In addition to water analysis, Sandia researchers say the technology may have applications beneficial to other industries. “Medical diagnostics applications might include enabling detection of diseases that produce anomalous cell morphology, such as cancer, sickle cell anemia, and leukemia,” said Carrie Burchard, a business development manager at Sandia. “In laboratories, iDEP could contribute to differential sorting of live and dead cells in cell culturing, and allow for protein isolation and concentration, sample concentration and focusing, analytical chemistry, and mass spectrometry for proteomics and drug discovery,” she said.

iDEP also could enable verification of biological decontamination efficacy for viable cell populations — as contrasted to inactivated cells and denatured proteins. For homeland security and public health purposes, it could improve water analysis and spore and vegetative cell differentiation. In industrial settings, iDEP could separate nanoparticles and nanotubes for materials synthesis.

How iDEP works

First reported by Pohl in 1951, dielectrophoresis is the movement of particles toward concentrated electric fields. The magnitude and direction of this motion depends on the size and shape of the particle as well as on the difference in conductivity between the particle and the suspending fluid. Thus, cell types can be sorted dielectrophoretically on the basis of shape and size, and dead cells separated from live on the basis of their higher conductivity.

Conventional dielectrophoretic sorters place electrodes within a sampling device and use the non-uniform electric field adjacent to electrodes to provoke dielectrophoretic motion of cells. Unfortunately, these electrodes require costly microfabrication, produce bubbles and electrolysis products that can harm device operation, and can damage cells with their strong field gradients.

In contrast, iDEP places electrodes outside the device. Current from the electrodes conducts through the particle-bearing liquid into the device where patterned walls or insulating obstacles produce the required non-uniform electric field. This arrangement eliminates many of the disadvantages of conventional devices: insulating structures can be replicated economically, produce no electrolytic effect, and can be contoured to be gentle on cells.

Source: Sandia National Laboratories