'Tractor beam' traps protein molecules

April 12 2006

A paper that outlines a new method to use a beam of light to trap protein molecules and make them dance in space has earned a place in the *Proceedings of the National Academy of Sciences Early Edition*.

The technique, developed by a team from the Department of Energy's Oak Ridge National Laboratory, California Institute of Technology and Protein Discovery, is more than just a novelty, however, as it is useful for separating, concentrating and analyzing proteins quickly with high sensitivity and selectivity.

"With this technique, we can steer DNA or other biomolecules for transport in three dimensions and also separate them according to size and their isoelectric point," said Chuck Witkowski, a co-author and president and chief executive officer of Protein Discovery, a Knoxville startup company. The ability to perform these functions with high efficiency and precision has applications for medical diagnostics and as a discovery tool.

The technique, called photoelectrophoretic localization and transport, or PELT, involves shining a highly focused beam of light on semiconductor material and using electric fields to move the proteins. Force-field traps are created by a photocurrent focused at the illuminated areas of the semiconductor. In contrast to traditional electrophoresis, which uses high voltage, this approach permits researchers to dynamically change characteristics of the electric field in three dimensions in real time using computer-controlled software and low voltage.

"It's kind of like a tractor beam in 'Star Trek,' but this is science, not science fiction," said Nathan Lewis, a co-author and professor at California Institute of Technology.

Photoelectrophoretic is extremely versatile and offers several advantages over methods that use conventional electrophoresis, according to co-author Thomas Thundat of ORNL's Life Sciences Division.

"This technique provides an easier way to separate proteins and other biomolecules," Thundat said. "In addition to applications for diagnostics, this is a discovery tool that allows you to investigate photo-induced effects of a semiconductor-liquid interface."

This new method also overcomes limitations of conventional optical trapping techniques, commonly called optical tweezers, which are versatile but unable to transport objects smaller than the wavelength of light. Included in this category are many biomolecules such as DNA fragments, oligonucleotides, proteins and peptides. Instead, such small molecules must first be attached to larger particles called "handles." This and other techniques have significant limitations, according to authors of the PNAS paper.

While photoelectrophoretic localization and transport holds tremendous promise, Witkowski said much work remains to commercialize the technology. Down the road, however, he envisions this technology playing a significant role in the medical field, specifically for disease diagnostics.

Other authors of the paper are Dean Hageman and James Harkins IV of Protein Discovery, Bruce Warmack of ORNL's Engineering Science and Technology Division and Gil Brown of ORNL's Chemical Sciences Division. The paper will appear in an upcoming issue of *Applied Physical Sciences*, *Biophysics*, published by PNAS.

Source: ORNL