New mixing method for microchip-sized labs

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By alternating the flow of fluid through tiny plastic pipes, a team of mechanical engineers at New Jersey Institute of Technology (NJIT) has discovered a new and speedier way to mix liquids, which in turn will someday produce better and safer medications.
"Everybody looks at creating turbulence in three dimensions to mix liquids," said team leader Nadine Aubry, PhD, Jacobus distinguished professor and chair of the mechanical engineering department at NJIT. "We traded space for time, which is a much simpler way to handle this problem when space is at a premium."

A paper by Aubry and her team, "Electro osmotic Mixing in Microchannels," published in the Nov. 29, 2004 issue of Lab on a Chip, showed that mixing could be accomplished by changing the flow rates by simply varying the voltage applied to the electrodes that commonly pump the fluid through a micro-channel. This publication follows other journal articles about similar research using other types of pumping: the Aug. 15, 2004 issue of Analytical Chemistry as well as the May 19, 2003 issue of Lab on a Chip.

More recognition for Aubry's work has come from professional colleagues, who appointed her last month vice chair of the U.S. National Committee for Theoretical and Applied Mechanics. The Committee serves as a national forum for discussions on research, technology and education of mechanics, as well as represents the U.S. in international scientific activities related to mechanics.

"Normally when two pipes in a micro-scale chemical reactor meet, the two liquids fail to mix," said Aubry. But by switching the flow many times per second, the scientists were able to create - in just a second - a pseudo-turbulent flow that completely blended the two liquids. To demonstrate the method, Aubry used a "T" channel intersection whose segments were 200 microns wide by 120 microns deep – about twice the circumference of a human hair.

The method caused the interface between the two liquids to stretch, fold, and sweep through, allowing the liquids to mix quickly after traveling only two millimeters down the channel. Aubry expects the new methods to have many useful applications, especially in the pharmaceutical industry.

"The process will be useful in the preliminary phases of drug discovery," she said, "where reagents need to be well-mixed to produce purer test drugs with fewer unwanted by-products." Her process will also help engineers design smaller, more sensitive detectors for nerve gases and pollutants. And on the domestic front, inexpensive lab-on-a-chip devices could be used to make sensors that will detect rotting food in kitchen refrigerators.

Aubry is the co-director of NJIT's Keck Laboratory, a biotechnology lab whose world-class technology can help identify and manipulate bacteria, viruses and cancer cells. She received her bachelor's degree in mechanical engineering from the National Polytechnic Institute in Grenoble, France, her master's degree in mechanical engineering from the Scientific University of Grenoble and her doctorate in mechanical and aerospace engineering from Cornell University, N.Y.

She has served as a member of the National Aeronautics and Space Engineering Board's Air Force Office of Scientific Research (AFOSR) Panel and as a member of the National Research Council Panel for the NASA Administrator's Fellowship Program. She is a recipient of the

Presidential Young Investigator Award from the National Science Foundation and the Ralph R. Teetor Award from the Society of Automotive Engineers.

Aubry is looking forward to continuing her micro-fluidic investigations. "Fluid mechanics has always been at the forefront of engineering and science," she said. "The prominent role that it now plays in emerging areas such as nanotechnology and biomedicine makes it a particularly exciting field."

Source: New Jersey Institute of Technology

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