

Lab on a chip´ offers early-warning possibilities

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Published Online December 23, 2001

When integrated circuits got put on chips and in ever smaller arrays, we got computers you can hold in the palm of your hand, with more power than the computers that ran the Apollo moon missions.

Some University of Illinois scientists are working to do the same kind of thing with chemical and biological processes by mixing biology, chemistry and technology at a molecular level.

Among other things, that could result in a kind of “lab on a chip” able to quickly detect biological and chemical weapons, said Chang Liu, a UI electrical and computer engineering professor.

Liu, UI physicist Steve Sligar and colleagues are working at nano scale – a nanometer is a billionth of a meter – to create processes for mass manufacturing such devices small and inexpensive enough to be carried by every soldier, and for other broad-use purposes.

“You can attach them to a faucet, and you can monitor your water supply,” said Liu, a professor in the UI Microelectronics Laboratory. “You want those kind of systems to be lightweight, to be portable, to be easy to operate.”

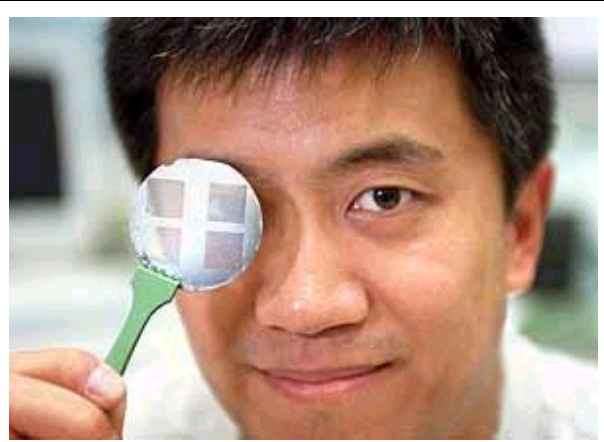
The chips also might be used in medical applications, say fast, relatively inexpensive DNA and protein analysis that could allow a doctor to identify and head off problems very early, or even be used as the basis for developing custom treatments.

Sligar said the researchers are leveraging the kind of speed, selectivity and sensitivity the body exhibits, as with enzymes that differentiate between very specific components of cells and act accordingly. With the lab on a chip, the idea is to detect, for instance, a single anthrax molecule in a gallon of water or a single precancer cell among a million good cells, Liu and Sligar said.

“Most of the major advances that are happening are happening at these interfacial areas” where fields such as biology, chemistry, physics and engineering meet, said Sligar, a biochemistry, chemistry, biophysics and basic medical sciences professor.

“There's a huge amount of money that the government has been investing in this nano science and engineering,” he said.

Liu and Sligar are part of a Nanoscale Science and Engineering Center that includes a half dozen other Illinois institutions, among them Northwestern, the lead institution, the University of Chicago and Argonne National Laboratory.



University of Illinois Professor Chang Liu peeks through a chip wafer intended for 'multi-well chemical reaction systems' - a lab on a chip - in his office at the UI Microelectronics Lab in Urbana.

The center, which means about \$1.3 million to the UI including state matching funds, is one of six nanotechnology centers announced recently by the National Science Foundation. Other agencies, such as the National Cancer Institute, are also interested in the work.

UI graduate students David Bullen, Danny Wang, Sam Lu and Kee Ryu also are working on the research. What they're working on, essentially, is a way to move processes like those performed in test tubes at labs, which can take days to produce results, into tiny wells on chips filled with biological and chemical materials designed to do many tests quickly and simultaneously. "Our goal is to pack them into a miniaturized, integrated format," Liu said.

Liu has worked on preparing surfaces for such uses, but his focus now is on technology to place the arrays on the chips in the desired patterns.

Writing them on the chip's surface might be a better way of characterizing it. The method involves what is basically a microscopic pen that's coated in the chemical "ink" then moved over the chip using tools such as an atomic force microscope.

That "dip pen nanotechnology," or DPN, is used now to pattern chips but generally with one pen tip at a time in a slow, painstaking and relatively expensive process.

The UI researchers are working on a system for employing multiple pens in concert to speed up the process and reduce its cost, a step in the direction of being able to mass produce such chips.