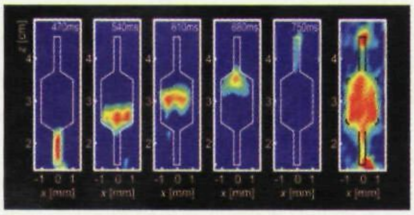
Emerging Technologies

NMR comes to lab-on-a-chip

Nuclear magnetic resonance (NMR) remains a powerful analytical tool for studying the chemical composition of macroscopic samples. Its application to microfluidic chip devices, however, has been hampered by low sensitivity.

Scientists from Lawrence Berkeley Laboratory and the Univ. of California, Berkeley, have devised a solution by making NMR technology compatible with microfluidic "lab-on-a-chip" devices. This breakthrough holds great promise for biomedical research, the detection of biohazards and toxic chemicals, and other endeavors in which the chemical composition of a fluid must be determined.



Developers: A team of scientists at Lawrence Berkeley Laboratory and the Univ. of California at Berkeley.

What's new: The use of NMR technology with microfluidic labs-on-a-chip.

How it works: The two basic actions of NMR, encoding and detection, are separated, and scientists inject hyperpolarized nuclei into the fluid samples for better sensitivity.

Applications: Biomedical research, detection of biohazards and toxic chemicals, and any other endeavors in which the chemical composition of a fluid must be determined.

Web site: www.lbl.gov

Boosting sensitivity

When atomic nuclei align their axes along the lines of a magnetic field, some will point "up" and some will point "down." Obtaining an NMR signal depends on an excess of nuclei in a sample with spins pointing in one direction or the other. However, the natural population difference in a fluid sample is too small to get an adequate NMR signal.

To overcome this low spin polarization, the researchers have been injecting their samples with xenon whose atomic nuclei have been hyperpolarized by laser light. Hyperpolarized xenon boosts the sensitivity of a sample by at least four orders of magnitude and, xenon being inert, does not interfere with the other sample constituents as it is carried along in the flow.

Remote NMR detection

With the addition of xenon, detection of the NMR signal is then carried out through a technique called remote NMR detection. This process allows the encoding and detection phases to be carried out independently, rather than within the same device as in conventional NMR. By staging the encoding and detection phases at separate sites, each site can be customized to obtain optimal results.

"Remote detection of the NMR signal overcomes the sensitivity limitation of NMR, and enables spatially resolved imaging in addition to time-of-flight measurements," says Christian Hilty of the Berkeley Lab.

Currently, the most common way to analyze gas flow in a microfluidic device is to inject it with marker particles that will fluoresce under optical illumination. Using remote NMR offers several advantages.

"With remote NMR detection, we don't need the addition of markers that perturb the flow because we can use the spins of the hyperpolarized xenon nuclei," says Hilty. "Also, when we apply the hyperpolarized xenon for the encoding step of remote detection, we can individually tag a fluid sample in any and all points within the device, whereas we can inject a fluorescent marker only at a device's inlet."

Creating antibodies

Researchers from Imperial College London, UK, have recently discovered that a large proportion of antibodies will only bind to bacterial proteins that contain a precise sequence in their C-terminus. These specifically binding antibodies can be created quickly and reliably since thousands of important bacterial proteins have already been identified. The researchers demonstrated the application of this method by producing antibodies against a group of bacterial proteins in just a few weeks, which would have taken several years with traditional methods.

>>More info: www.bbsrc.ac.uk

Enhancing gene therapy

Researchers at the Mount Sinai School of Medicine, New York, N.Y., have developed a technique for inserting genes into specific sites of the genome in liver cells. The genes are inserted into non-coding regions of the genome so there is no danger of interfering with the functioning of other genes. Once inserted, the gene remains a permanent part of the cell's genome, and only a few applications would suffice to permanently correct a disease.

>>More info: www.mssm.edu

Beating bacteria

Learning how bacteria handle the body's immune response is the first step in developing more effective antibiotics. To that end, researchers from the Georgia Institute of Technology, Atlanta, and the John Innes Center, Norwich, UK, have discovered the mechanism by which *E. coli* thwarts the body's natural defense responses. The body produces nitric oxide to fight infections, and *E. coli* turns the poisonous nitric oxide into something that is harmless to the cell. Interfering with this mechanism may lead to better antibiotics and treatments.

>>More info: www.gatech.edu