NMR v LOC

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Ezine

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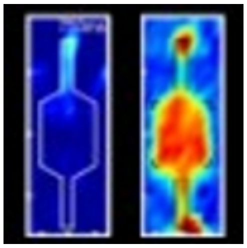
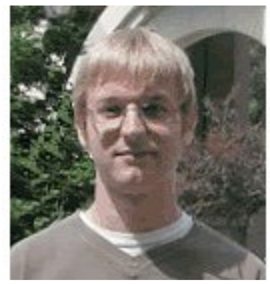
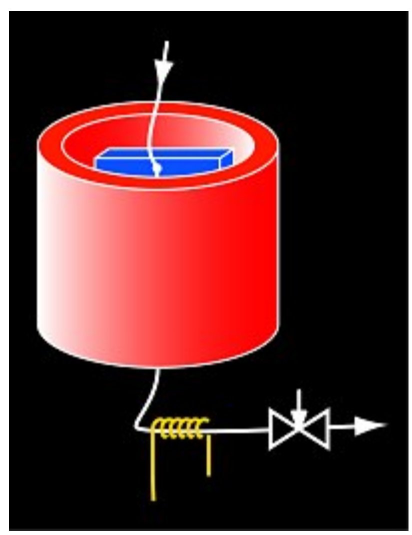




Christian Hilty

Alexander Pines



US researchers have demonstrated that NMR is compatible with microfluidic, lab-on-chip devices, opening the door on a whole range of analytical applications based on such devices for biomedical research and medical diagnostics, biohazard and toxic chemical detection, and industrial analysis.

Alexander Pines of the Lawrence Berkeley National Laboratory (Berkeley Lab) and the University of California, Berkeley, and colleagues Christian Hilty, Erin McDonnell, Josef Granwehr, Kimberly Pierce, and Song-I Han, explain how they have circumvented the problem of optimizing the two basic steps of NMR - signal encoding and detection - by separating them physically to yield "remote NMR". Their approach also adds an important new dimension to the study of fluid flow dynamics with the possibility of time-of-flight measurements.

"Remote detection of the NMR signal overcomes the sensitivity limitation of NMR and enables spatially resolved imaging in addition to time-of-flight measurements," explains chemist Christian Hilty, "Our approach also offers the unique advantage of being non-invasive. We can use it to measure microfluidic flow without the introduction of foreign tracer particles. This is important for the design and the operation of microfluidic devices."

Until now, NMR has found little use in the emerging field of microfluidics because of sensitivity problems due to the tiny volumes involved and the low natural population difference.

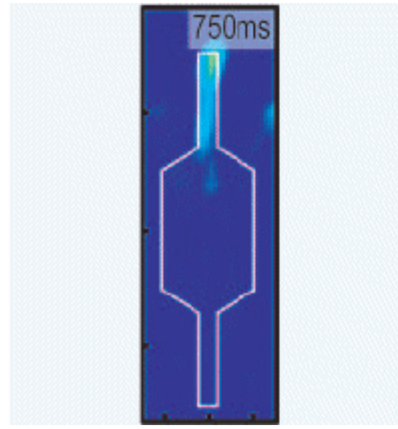
Pines and his research group found that adding xenon nuclei hyperpolarized in laser light would boost NMR sensitivity by at least four orders of magnitude when added to a microfluid sample. Xenon's spin-relaxation time is of the order of minutes, so can transport the encoded NMR data to a separate site for detection and so allow the two steps to be optimized. "Xenon's long spin-relaxation time makes it an ideal carrier of an NMR signal for remote measurements of gas flow," explains Hilty.

LOC devices currently use fluorescent marker particles to track movements and changes. Remote NMR offers many advantages over this approach. "With remote detection of NMR, we don't need the addition of markers that perturb the flow because we can use the spins of the hyperpolarized xenon nuclei," Hilty adds. "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." According to Hilty and Pines, their NMR remote detection technology is ready to be applied to any existing microfluidic device, so long as the fluid is transported to the detection site within the spin relaxation time of encoded NMR information.

Another limiting factor for the widespread use of NMR with microfluidic devices is the relatively high cost of an NMR spectrometer. Pines and his research group are working on the development of alternative, less expensive means of detecting encoded NMR signals - for example, a magnetometer. Preliminary results hold great promise for developing this technology still further.

"Our method allows us to measure profiles of microfluidic flow non-invasively," Hilty told SpectroscopyNOW, "and without introduction of tracer particles that can potentially alter the flow. Therefore, the measurement will be more accurate." Microfluidic devices often take advantage of complex interactions to provide a desired flow pattern, so these measurements are particularly important for the design of devices, he adds.

NMR at the Lab-on-Chip scale



NMR and LOC go with the flow

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