Reversible microlenses to speed chemical detection

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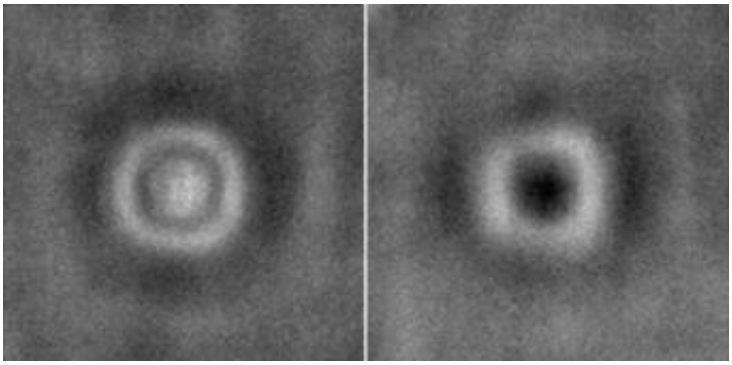

On the left, a microlens is in the 'on' state and ready to detect. The right shows the microlens in the 'off' state after it has detected its target chemical.

Scientists at Georgia Tech have created technology capable of detecting trace amounts of biological or chemical agents in a matter of seconds, much faster than traditional methods, which can take hours or up to a day.

The system uses reusable hydrogel microlenses so small that millions of them can fit on a one-inch-square plate. It could greatly enhance the ability of authorities responding to a biological or chemical weapons attack as well as increase the speed of medical testing. The research appears as an early view online for the chemistry journal Angawandte Chemie.

The microlenses make use of the antibody-antigen binding, the same process used by the human immune system, to detect biological or chemical agents. When antibodies on the microlenses come into contact with the antigen they are set to detect, they bind, causing the lenses to swell and become less dense. By projecting an image through the tiny lenses, scientists can view this swelling as a change in the microlens' focal length. If the projected image is normally in focus, it goes out of focus when it comes into contact with the substance.

"These are reversible, so you can use the same lenses over and over again. This is the first time someone has done this with microlenses," said L. Andrew Lyon, associate professor in the School of Chemistry and Biochemistry at the Georgia Institute of Technology.

Lyon and colleagues tested their system on its ability to detect biotin, a B-complex vitamin. To make the two-micrometer-wide microlenses, they coated the surface of a flexible polymeric hydrogel microsphere with the antigen biotin and aminobenzophenone (ABP), a photo-cross-linking agent, which is able to chemically attach to other molecules when exposed to UV light. Adhering these microparticles on a glass substrate causes them to deform into microlenses. After binding the biotin with its antibody, researchers hit it with ultraviolet light, causing the ABP to react with the antibody, attaching it to the microlens irreversibly. The microlenses are now ready to do their job.

"When you expose the lens to a solution that contains the antigen, it will compete for the binding site on the antibody. When the antigen and antibody bind, the lens swells and become less dense, changing its focus," said Lyon.

Once developed into a device, the microlenses' ability to conduct rapid chemical and biological tests could lead to significant savings in healthcare costs as many blood tests could be run in a physician's office

rather than being sent to an outside lab. It could also allow authorities to rapidly detect and identify a toxic chemical in the event of a spill or terrorist attack.

Many traditional analyses using enzyme or fluorophore-labeled antibodies can take up to a day or more and require large pieces of expensive equipment. A device built with microlenses could be handheld, since standard technologies currently exist that integrate microlenses into compact optical systems.

"The beauty of this is that the microlenses are very tunable in terms of sensitivity," said Lyon. "You can also make arrays so you can detect multiple components on one sample, allowing you to multiplex your detection. Whereas now, each separate thing that doctors look for in a blood test is a different test they have to do in the lab."

Lyon said the next step in developing the microlens sensors is to test the technology's performance in complex biological fluids, like blood serum.

Source: Georgia Institute of Technology