Tiny, reusable sensing chip could lead to new point-of-care medical tests

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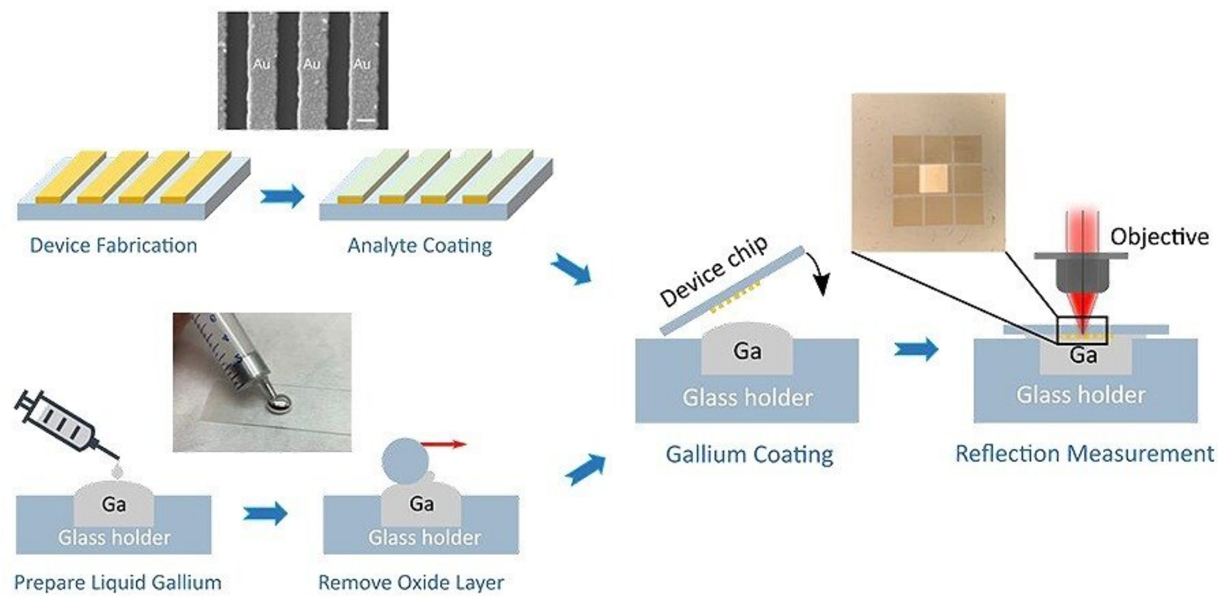

Graphical abstract. Credit: DOI: 10.1002/adma.202107950

The proliferation of point-of-care testing, from at-home blood glucose meters to COVID-19 rapid tests, is accelerating and improving medical care.

Continuing to upgrade the sensing technology that is fueling the growth of these products, however, is becoming increasingly challenging.

Some optical sensing chips, for example, contain nanostructures that are nearly as small as the biological and chemical molecules they're searching for. These nanostructures improve the sensor's ability to detect molecules. But their diminutive dimensions make it difficult to guide the molecules to the correct area of the sensor.

"It's kind of like building a new racing car that is more streamlined and therefore runs faster, but its door is made too small for the driver to enter the car," says Peter Q. Liu, Ph.D., assistant professor of electrical engineering at the University at Buffalo School of Engineering and Applied Sciences.

Liu—along with Xianglong Miao, a Ph.D. candidate in his lab, and Ting Shan Luk, Ph.D., at the Center for Integrated Nanotechnologies, Sandia National Laboratories—have created a new sensor that takes aim at this problem.

Described in a study published in *Advanced Materials* in January, the sensor uses surface-enhanced infrared absorption (SEIRA) spectroscopy.

Spectroscopy involves studying how light interacts with matter. While infrared absorption spectroscopy has been around for more than 100 years, researchers are still trying to make the technology more powerful, affordable and versatile.

As the name suggests, these sensors work with light in the mid-infrared band of the electromagnetic spectrum, which is used by remote controls, night-vision goggles and other products.

The new sensor consists of several arrays of tiny rectangular strips of gold. Engineers dipped the strips in 1-octadecanethiol, which is a chemical compound (often abbreviated as ODT) that they chose to identify.

Researchers then added a drop of liquid metal—in this case, gallium—to serve as the sensor's base. Lastly, they placed a thin glass cover on top to form a sandwich-like structure.

The design of the sensor, with its layers and cavities, creates what researchers call a "nanopatch antenna." The antenna both funnels molecules into the cavities and absorbs enough infrared light to analyze biological and chemical samples.

"Even a single layer of molecule in our sensor can lead to a 10% change in the amount of light reflected, whereas a typical sensor may only produce a 1% change," says Liu, who adds that the team will continue to refine the sensor with the goal of using it for bioanalytical sensing and medical diagnostics applications, such as sensing biomarkers linked to certain diseases.

After measuring the ODT, the researchers removed the liquid gallium from the sensor chip surface with a swab. This process allows the sensor to be reused, which could make it more cost-effective than similar alternatives.

"The structure of our sensor makes it suitable for point-of-care applications that can be implemented by a nurse on a patient, or even outside the hospital in a patient's home," he says.

More information: Xianglong Miao et al, Liquid-Metal-Based Nanophotonic Structures for High-Performance SEIRA Sensing, *Advanced Materials* (2022). DOI: 10.1002/adma.202107950

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