Microlaser Bandage Measures Glucose Without Drawing Blood

SINGAPORE, July 15, 2024 — A research team at Nanyang Technological University, Singapore (NTU Singapore) has developed a wearable sensor based on microlasers to measure biomarkers found in sweat. The bandage-like device could provide a way to monitor blood sugar levels noninvasively.

Human sweat contains biomarkers such as glucose, lactate, and urea that indicate various health conditions and can be collected in a noninvasive and painless manner, making it ideal for daily monitoring, the researchers said.

Diabetic patients typically use an invasive finger prick test to self-monitor blood glucose levels. A small drop is drawn from the finger and put into contact with a strip which is inserted into a portable glucose meter for reading. Alternatively, there are sensor-based monitoring devices, which can be expensive and rigid and must be attached to a patient's skin over prolonged periods of time.

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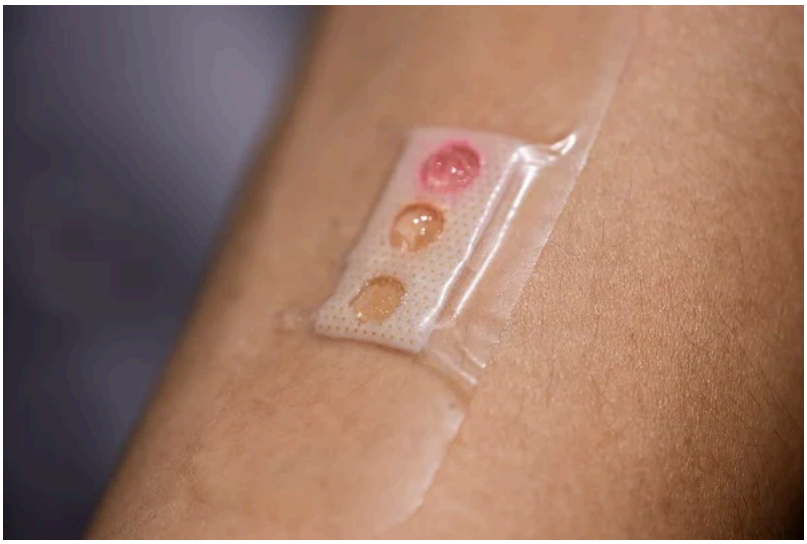
*The bandage-like device developed by NTU Singapore is comprised of microlaser sensors embedded in liquid **crystal** droplets. The sensors are customized to pick up three different types of biomarkers (lactate, glucose, and urea). A different colored **liquid crystal** dot on the bandage distinguishes each biomarker. Courtesy of NTU Singapore.*

By encapsulating a microlaser in liquid crystal droplets and embedding the liquid within a soft hydrogel film, the NTU team created a compact and flexible light-based



sensing device — like a bandage that can provide highly accurate biomarker readings within minutes.

“Our innovation represents a non-invasive, quick and effective way for diabetic patients to monitor their health,” said Chen Yu-Cheng, director of NTU’s Centre for Biodevices and Bioinformatics. “By combining a microlaser with a soft hydrogel film, we have demonstrated the feasibility of a wearable laser to provide a more pleasant health monitoring experience for patients.”

The NTU team created their bandage device by embedding microlasers in liquid crystal droplets. The microlasers are customized to pick up three different types of biomarkers (lactate, glucose, and urea). A different colored liquid crystal dot on the device distinguishes each biomarker.

When sweat interacts with the bandage device, the amount of light emitted by the microlasers fluctuates based on the concentration of biomarkers present. To read the biomarker levels, users shine a light source on the device, and the light emitted from the microlaser sensors is analyzed and translated using a mobile application.

In real-live experiments, the bandage device successfully picked up tiny fluctuations of glucose, lactate and urea levels in sweat down to 0.001 mm, which is 100x better than current similar technology, according to the researchers.

The NTU team believes their innovation to be the first reported wearable sensing device capable of measuring multiple biomarkers in sweat with ultra-high sensitivity and dynamic range. The sensitivity enables tracking of a dynamic range (low to high) in biomarkers levels, which provide comprehensive information on patients’ health.

“Our device is capable of detecting both the high and low range of biomarkers levels. This is particularly beneficial for diabetic patients as current similar health monitoring devices focus on tracking only high glucose levels, but not abnormal or

low glucose levels, which may indicate other health complications," said Nie Ningyuan, first author of the study and a PhD candidate at NTU. "In comparison, our device will provide a clearer picture of the users' health condition with a variety of readings captured."

To further develop the technology, the research team plans to fine-tune the microlaser sensors to detect a wider variety of substances, including drugs and other chemicals found in sweat.

The research was published in *Analytical Chemistry* (www.doi.org/10.1021/acs.analchem.4c00979).