Applications

NTU wearable microlasers reveal glucose levels in sweat

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Singapore project points to new non-invasive ways to monitor biomarkers.

Wearable sensors are an attractive approach to health monitoring and biomarker detection, and developments in flexible photonics are making such devices increasingly versatile.

A project at Singapore's Nanyang Technological University (**NTU**) has now developed a photonic device able to be worn like a sticking plaster and capable of analyzing sweat for signs of disease.

Sweat it out: perspiration data

Published in **Analytical Chemistry**, the findings could point to improved health monitoring via wearable sensors, and show how advances in thin film laser technology can be exploited in the wearables sector.

The NTU sensor was developed for the analysis of human sweat since that liquid is a source of valuable biomarkers, including glucose, lactate and urea. These chemicals can indicate various health conditions and be collected in a non-invasive and painless manner, making them ideal for daily monitoring.

"Optical resonators have emerged as a tool for flexible photonic sensors, but direct monitoring of information on human skin remains challenging due to the subtle biological signals and complex tissue interface," commented the NTU team in its paper.

"To tackle the current challenges, we developed a functional thin film laser formed by encapsulating liquid crystal droplet lasers in a flexible hydrogel for monitoring metabolites in human sweat."

Better monitoring of diabetes and health complications

At the heart of the NTU device are the liquid crystal droplet lasers, building on research into how liquid crystal phases of the correct chemistry and doped with a suitable gain medium can work as optical resonators and emit light.

NTU manufactured a functional thin film laser by encapsulating these liquid crystal droplet laser sources in a flexible hydrogel, with the three-dimensional cross-linked hydrophilic polymer serving as the adhesive layer. When attached to the skin, small molecules such as sweat can penetrate this structure and influence the amount of light emitted by the microlasers, due to their effect on the inherent whispering gallery modes of the resonators.

As a result the amount of light emitted by the microlasers fluctuates based on the concentration of those molecular biomarkers. Shining a light source on the plaster and analyzing the emissions from the microlaser sensors can then be translated into data about the sweat, according to the NTU team.

In trials the NTU plaster successfully picked up fluctuations of glucose, lactate and urea levels in sweat, performing "100 times better than current similar technology," said the project.

NTU believes this to be the first wearable sensing device capable of measuring multiple biomarkers in sweat with ultra-high sensitivity and dynamic range, a step towards providing comprehensive information on patients' health.

"Our device is capable of detecting both the high and low range of biomarkers levels," said NTU's Nie Ningyuan. "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."