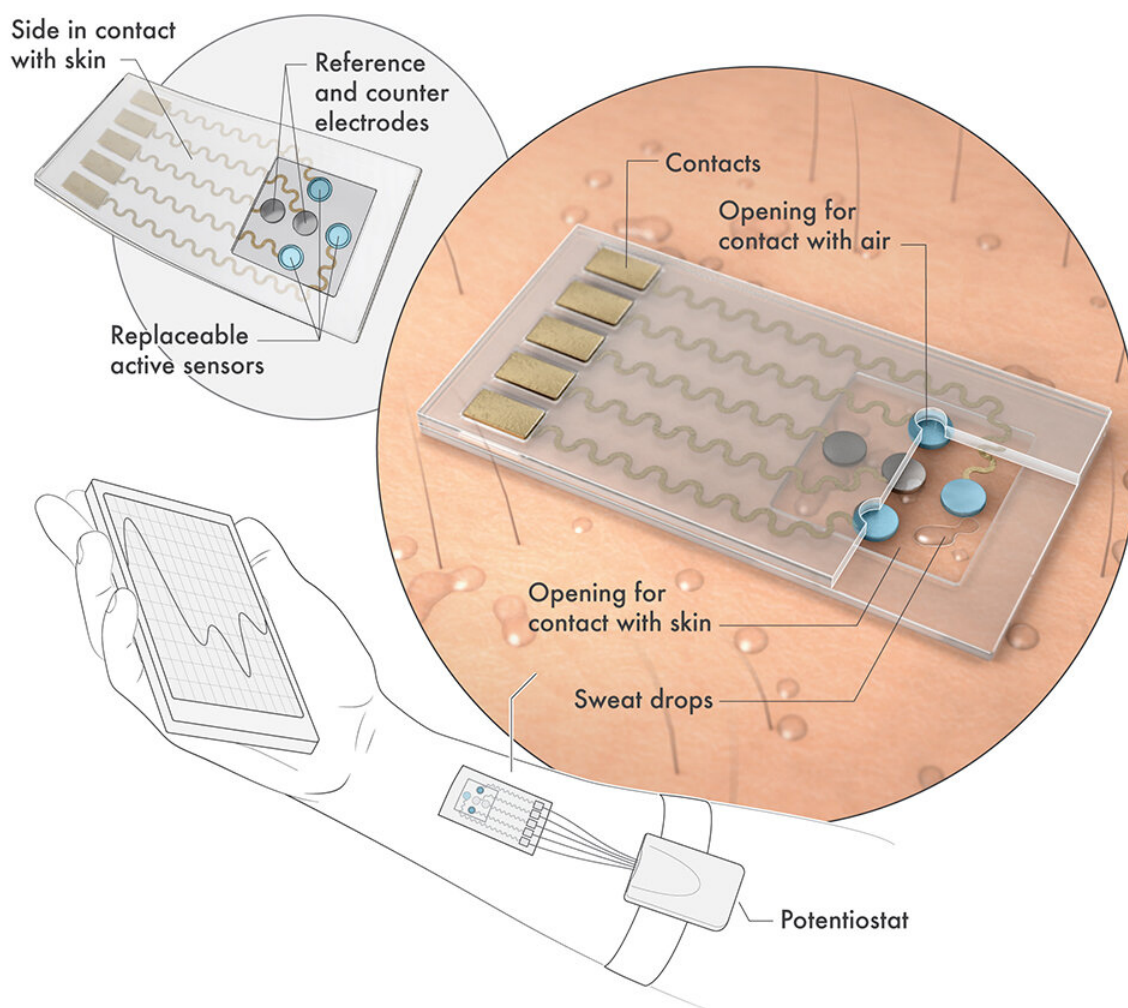


Wristbands do a health check while you work out

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A schematic diagram of the sensor system showing how the drops of sweat are directed towards the electrodes that are coated with enzymes that can detect low

concentrations of target compounds. Credit: Reproduced with permission from reference 1 © 2019 John Wiley & Sons

Next-generation fitness sensors could give deeper insights into human health through noninvasive testing of bodily fluids. A stretchy patch developed at KAUST could help this approach by making it easier to analyze sweat for critical biomarkers.

Human perspiration contains trace amounts of organic molecules that can act as measurable health indicators—glucose fluctuations, for example, may point to blood sugar problems, while high levels of lactic acid could signal oxygen deficiencies. To detect these molecules, researchers are developing flexible prototypes that sit on the skin and direct [sweat](#) toward special enzyme-coated electrodes. The specific nature of enzyme-substrate binding enables these sensors to electrically detect very low concentrations of target compounds.

One obstacle with enzyme biosensors, however, is their relatively short lifetimes. "Even though [human skin](#) is quite soft, it can delaminate the enzyme layer right off the biosensor," says Yongjiu Lei, a Ph.D. student at KAUST.

Lei and his colleagues in Husam Alshareef's group have now developed a wearable system that can handle the rigors of skin contact and deliver improved biomarker detection. Their device runs on a thin, flat ceramic known as MXene that resembles graphene but contains a mixture of carbon and titanium atoms. The [metallic conductivity](#) and low toxicity of this 2-D material make it an ideal platform for enzyme sensors, according to recent studies.

The team attached tiny dye nanoparticles to MXene flakes to boost its

sensitivity to hydrogen peroxide, the main by-product of enzyme-catalyzed reactions in sweat. Then, they encapsulated the flakes in mechanically tough carbon nanotube fibers and transferred the composite onto a membrane designed to draw sweat through without pooling. A final coating of glucose or lactose-oxidase enzymes completed the electrode assembly.

The new electrodes could be repeatedly swapped in or out of a stretchy polymer patch that both absorbs sweat and transmits the measured signals of [hydrogen peroxide](#) to an external source, such as a smartphone. When the team placed the biosensor into a wristband worn by volunteers riding stationary bicycles, they saw lactose concentrations in sweat rise and fall in correlation with workout intensities. Changes in glucose levels could also be tracked as accurately in sweat as it is in blood.

"We are working with KAUST and international collaborators under the umbrella of the Sensors Initiative to integrate tiny electrical generators into the patch," says Alshareef, who led the project. "This will enable the patch to create its own power for personalized health monitoring."

More information: Yongjiu Lei et al, A MXene-Based Wearable Biosensor System for High-Performance In Vitro Perspiration Analysis, *Small* (2019). [DOI: 10.1002/sml.201901190](https://doi.org/10.1002/sml.201901190)

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