Transistor-based sensors offer hope for rapid diagnosis and treatment for COVID-19 and other infections

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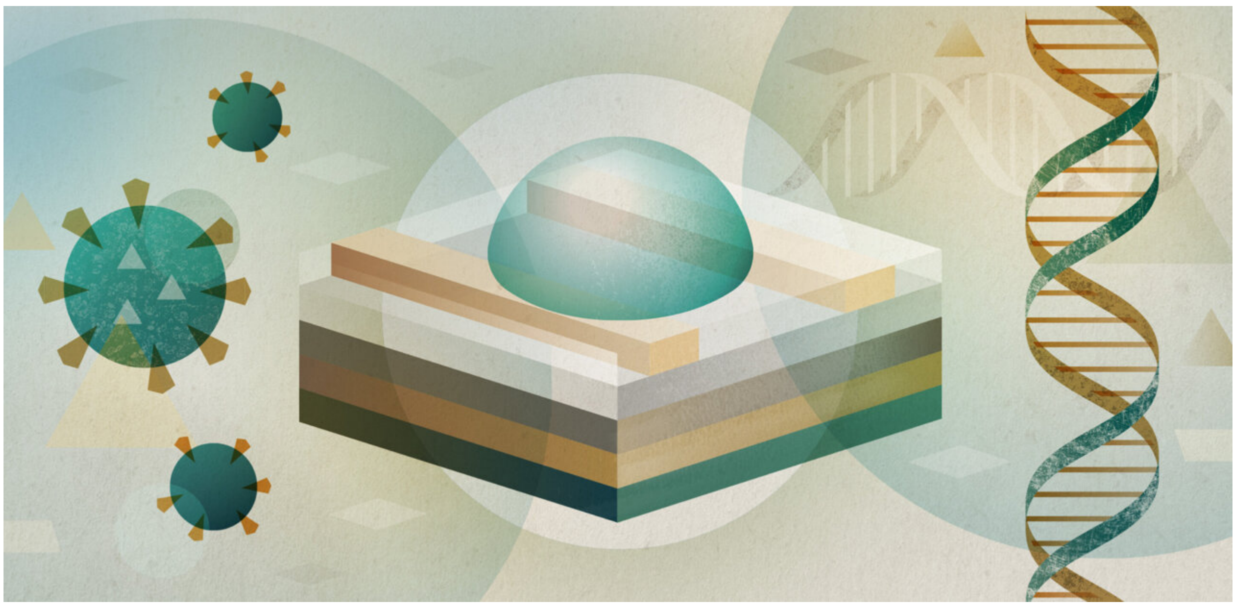

An international research team led by KAUST has engineered a solid-state metal oxide transistor-based technology that can rapidly detect the SARS-CoV-2 virus in biosamples. Credit: KAUST; Xavier Pita

A solid-state metal oxide transistor-based technology can detect tiny quantities of biomolecules, such as DNA and COVID-19 spike protein, in less than two minutes.

This game-changing approach engineered by a KAUST-led international team could make COVID-19 and many other diseases faster and easier to diagnose and tackle.

Solid-state transistors have emerged as choice candidates for directly sensing biomolecules of interest, or analytes, with high sensitivity and selectivity. They can convert interactions between sensor surface and analyte into an amplified electrical signal. Also, they don't require time-consuming sample preparation steps or specialized equipment. Multiple platforms have used silicon nanowire-based transistors that, despite having excellent biosensing capabilities, involve top-down manufacturing approaches that are complex and expensive to implement. Plus, they are difficult to scale up and customize to a specific target.

Thomas Anthopoulos and coworkers used solid-state metal oxide transistors with a tunable surface chemistry and exceptional operating characteristics to design a biosensor that had a unique tri-channel configuration. This configuration comprises a central sensing channel flanked by two conventional channels.

The team had unexpectedly discovered that an analyte droplet located outside the conventional channel area still triggered some response in a typical metal oxide transistor-based sensor. This inspired them to design the tri-channel device, explains Yen-Hung Lin, who co-led the study.

The researchers successively layered indium oxide and zinc oxide solutions on a support to form a so-called semiconducting heterojunction. Next, they manufactured the electrodes on the heterojunction before depositing another zinc oxide layer on the electron transporting interface. They sequentially anchored a target-specific receptor molecule to modulate the selectivity and butyric acid to prevent direct contact between the sensing channel and the fluids used to disperse the analytes to this top layer.

"We were absolutely thrilled to see the enhanced performance when we first used this design to sense the presence of DNA," Anthopoulos says.

In addition to detecting various types of DNA and the biotin-binding protein avidin at extremely low concentrations, the biosensor showed ultrasensitivity to the COVID-19 spike protein when target-specific antibody acceptors were immobilized to its surface. "We did anticipate extreme sensitivity but were not sure whether the analyte–receptor interactions would be strong enough to be sensed with high fidelity. It turned out that it was," he adds.

The team now plans to build a portable system that could simultaneously test for a variety of pathogens. "Our platform is ideal for developing sensor arrays featuring different types of receptors to detect multiple analytes in a single biosample," Anthopoulos says.

More information: Yen-Hung Lin et al, A Tri-Channel Oxide Transistor Concept for the Rapid Detection of Biomolecules Including the SARS-CoV-2 Spike Protein, *Advanced Materials* (2021). DOI: 10.1002/adma.202104608

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