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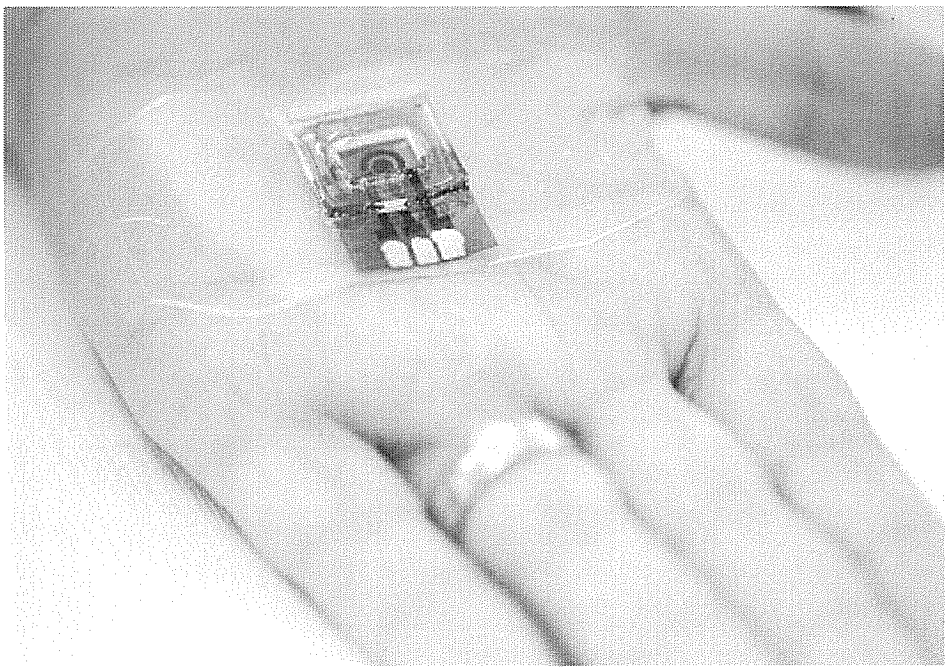
Better biosensors on edge

(*Nanowerk News*) Using a laser to burn patterns into a polymer sheet, KAUST researchers have created graphene electrodes that act as effective biosensors.

Graphene is a sheet of carbon, just one-atom thick, that is strong, flexible and highly conductive. Certain molecules can trigger an electrical response when they interact with graphene, making it potentially useful as an electrochemical sensor. One way to enhance its sensitivity is to create a large, accessible surface area of graphene by coating it inside three-dimension al porous materials.

However, this usually requires expensive manufacturing techniques or involves chemical binders that interfere with sensing. Despite these steps, graphene sheets often aggregate, reducing their overall surface area.

Professor of Material Science and Engineering Husam Alshareef and colleagues at the University have developed an alternative approach using a technique called laser scribing. This technique locally heats parts of a flexible polyimide polymer to 2500 degrees Celsius or more to form carbonized patterns of patches on the surface that act as electrodes.



This chemical sensor contains graphene-based electrodes that were inscribed into the underlying polymer using a laser. (Image: Alshareef/KAUST)

These black patches are about 33-micrometers thick, and their highly porous nature allows molecules to permeate the material. Inside the patches, the graphene sheets have exposed edges that are very effective at exchanging electrons with other molecules.

"Graphene-based electrodes with more edge-plane sites are effectively better than those relying on carbon or carbon-oxygen sites in the plane of the material," said the postdoc in Alshareef's group Pranati Nayak, who led the study (*Advanced Electronic Materials*, "Highly efficient laser scribed graphene electrodes for on-chip electrochemical sensing applications").

The researchers added platinum nanoparticle catalysts to one of the electrodes to speed up the electrochemical reactions with other molecules. In experiments with two different test molecules, this electrode could exchange electrons hundreds of times faster than other carbon-based electrodes and showed no loss in performance over 20 cycles of testing.

The team used this graphene-based electrode to build a sensor (see image) for three biologically important molecules: ascorbic acid, dopamine and uric acid. When the molecules hit the electrode surface, they release electrons, generating a current proportional to their concentration. Crucially, each molecule's electrochemical response was seen at a different voltage, meaning the device could measure their concentrations simultaneously and without interference.

The electrode accurately detected very small (micromolar) concentrations of the molecules, beating several rival electrodes on both sensitivity and the lower limits of detection. The researchers now hope to add traces of other atoms, such as nitrogen, to graphene to improve its sensing performance and to augment the electrodes with aptamers, short strands of DNA, RNA or peptides that bind to specific target molecules, to create new biosensors.

Source: *KAUST*

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