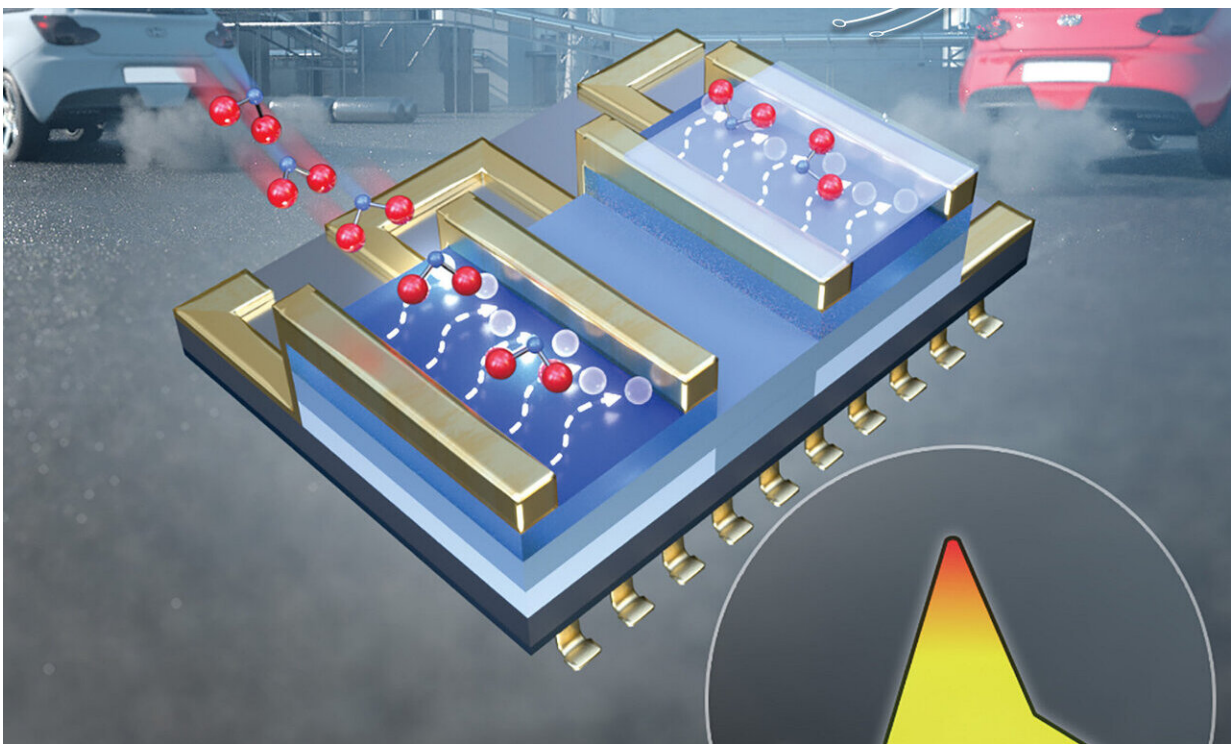


Early warning sensor sniffs out cities' harmful gas

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Credit: *ACS Sensors* (2020). DOI: 10.1021/acssensors.9b02318

An integrated detector device could form the basis of a distributed air-quality sensor network.

The design for an electronic sensor that sounds the alarm if toxic industrial and vehicle-exhaust gases exceed safe levels could lead to

cleaner air in many cities. KAUST researchers have developed a small, low-cost device that senses [nitrogen dioxide](#) (NO₂); it could be deployed in potential hotspots around cities, alerting authorities if levels of the harmful gas start to spike.

Most existing NO₂ detectors are large, complex machines suited to laboratory use, whereas the compact new device is designed to form part of a distributed network of air quality sensors. "Our sensor exhibits very high sensitivity and selectivity for NO₂, operates at room temperature and has very low power consumption," says Mani Vijjapu, a Ph.D. student in Khaled Salama's lab, who led the research.

However, the biggest advantage over previous designs is that the [gas detector](#) brings together all the necessary sensing and signal processing components within a simple, fully integrated system, Vijjapu says. Despite its simplicity, the device's output signal varies according to NO₂ concentration.

The gas detector's high performance, low power consumption and fully integrated design all stem from the NO₂-sensing thin-film transistor at the core of the device. Previous sensors have used metal oxides that are sensitive to NO₂ only when heated or continuously irradiated with light. This time, the team used a semiconductor called indium gallium zinc oxide (IGZO). "As a gas sensor, the IGZO-based thin-film transistor has multifaceted benefits," says Sandeep Surya, a postdoctoral researcher in Salama's team.

The IGZO thin-film transistor acts as both an electronic component of the device and also as the NO₂-sensing layer. The strongly electron-accepting NO₂ molecule is drawn to the electrons on the transistor's surface. The more NO₂ molecules that adhere to the IGZO, the more electrons are depleted from its surface, altering its electronic output and triggering an NO₂ detection alert.

After a detection event, the sensor is reset by reviving the IGZO layer with the light from an integrated blue LED. Similar to a solar cell, the light generates negatively charged electrons and positively charged holes in the IGZO, which neutralizes the adsorbed NO₂ and releases it from the surface. "This is the first study to achieve sensing and revival of a semiconducting metal oxide-based thin-film transistor sensor at room temperature," says Surya.

"The next step is to translate our research into a prototype and maybe even a product by working with industry," Salama says. "We are also interested in exploring other materials to detect other hazardous gases in the environment."

More information: Mani Teja Vijjapu et al. Fully Integrated Indium Gallium Zinc Oxide NO₂ Gas Detector, *ACS Sensors* (2020). [DOI: 10.1021/acssensors.9b02318](https://doi.org/10.1021/acssensors.9b02318)

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