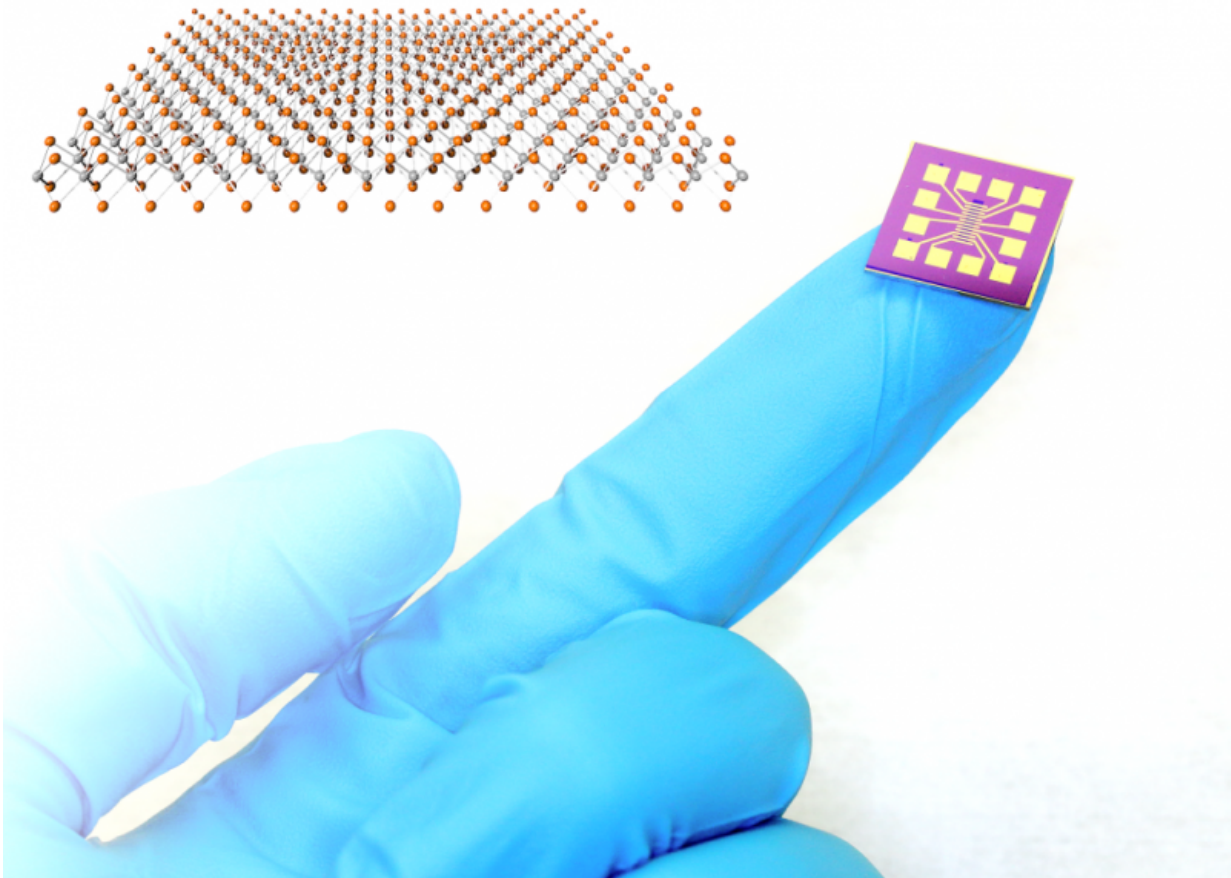


Ultra-fast, ultra-sensitive PtSe₂ gas sensors

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PtSe₂ gas sensor chip. Credit: Trinity College Dublin

Researchers from Trinity College Dublin, Ireland have shown that PtSe₂, a little-studied transition metal dichalcogenide has potential for a variety of uses. In particular, PtSe₂ is an excellent high performance gas

sensor, and fabrication is compatible with silicon chip foundrys.

Researchers from the Graphene Flagship, working at the AMBER centre in Trinity College Dublin, Ireland in collaboration with researchers from University of Siegen, Germany, and University of Vienna, Austria, have demonstrated ultrafast and highly sensitive [gas sensors](#) using platinum selenide (PtSe₂). This material – a transition metal dichalcogenide (TMD) – has promising potential in different areas of nanoelectronics, including optoelectronics as well as sensing. This research, published in *ACS Nano*, demonstrates the potential of PtSe₂ in a range of applications, and presents this little-studied material as an excellent candidate for further investigation.

The new TMD was created using a metal conversion method, in which thin platinum film is converted into PtSe₂ by thermally assisted conversion in selenium vapour at 400 °C. PtSe₂ now joins the growing class of stable TMDs. Georg Duesberg, from Trinity College Dublin, is the principal investigator of the study. He said "We performed a screening study of materials, to check a few different material combinations. The conversion of metals is helpful in the quest for new materials, because it is simple to do. Of the other combinations that worked, many immediately oxidised, so they were not stable. We were very lucky to find a sweet spot with this material, and to be able to synthesise it on a large scale."

One of the benefits of PtSe₂ is the method of fabrication, which is compatible with [silicon chip](#) fabrication. "We grow PtSe₂ at 400 °C which makes it potentially suitable for so-called back end of line (BEOL) processing. This means that it can be combined with existing device architectures to add new functionality," said Niall McEvoy, a researcher at Trinity College Dublin who performed the growth experiments. BEOL processing comes after the actual fabrication of integrated circuits of a silicon chip, It is crucial that the temperature is

less than 450 °C, to preserve the functionality of the integrated circuit. "This is very interesting for the Flagship's push towards industrial applications," added Duesberg. "This potentially can be grown on top of a chip. You can imagine using this material for the Internet of Things, sensors and so on."

To demonstrate possible applications for the new material, the researchers tested its performance in sensing NO₂. "All of our homegrown materials are tested as gas sensors. PtSe₂ showed excellent results, high sensitivity, excellent response time and nearly complete recovery," said Kangho Lee, a researcher at Trinity College Dublin who performed the gas sensing experiments. Gas molecules adsorbed onto the surface of the PtSe₂ change its conductivity, lowering the resistance. The researchers found that the PtSe₂ had extremely high sensitivity, measuring 100 ppb NO₂ at room temperature. The sensor was also extremely fast to respond to the gas – detecting low quantities of gas in only seconds – and recovering completely within a minute when the inert atmosphere was restored.

For commercial sensing applications, the sensor must be responsive only to specific gases, so that changes in environmental conditions can be monitored. McEvoy is optimistic that the PtSe₂ can be treated to have the selective sensing properties needed. "With some added processing steps, to engender selectivity, PtSe₂ could potentially be used in a wide array of industrial chemical sensing applications," he said. A potential route to selective sensing could be the addition of chemical groups that are responsive to the chosen gas.

More information: Chanyoung Yim et al. High-Performance Hybrid Electronic Devices from Layered PtSe₂ Films Grown at Low Temperature, *ACS Nano* (2016). [DOI: 10.1021/acsnano.6b04898](https://doi.org/10.1021/acsnano.6b04898)

Provided by Graphene Flagship

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