Conformally grown $PtSe_2$ on structured substrates as highly sensitive ammonia sensors

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Platinumdiselenide ($PtSe_2$) is a promising 2D material with remarkable properties [1] such as the transition from a bulk semimetal in bulk to a semiconductor when a few layers thin. Due the low-temperature synthesis and the high environmental stability it has very high potential for applications in electronics, photonics, and sensing [2].
Another stepstone for the use of 2D materials is in hybrid semiconductors devices [3], is the possibility to manufacture 3D structures with them. Here, we present a highly sensitive ammonia sensor in which the active surface has a 3D topography. The $PtSe_2$ is grown on the structured substrate with multiple trenches by conformal atomic layer deposition of platinum with subsequent selenization through thermally assisted conversion at a temperature of only 450 °C. In addition to the large surface-area-to-volume ratio characteristic for 2D materials which renders them ideal for chemical sensing, the 3D topography further increases the effective active sensing area by packaging more active material within less lateral physical space. The sensor showed a record high limit of detection (LOD) of 370 ppb for NH_3 [4]. In addition to this thus optimised sensor channel the methodology can be employed for the 3D integration of 2D materials.

References

[1] Maria O'Brien et al., 2D Mater., 2 (2016), p. 21004
[2] Chanyoung Yim et al., Nano Letters, 3 (2018) p. 1794
[3] Chanyoug Yim et al., ACS Nano, 10 (2016) p. 9550
[4] Maximilian Prechtl et al., Adv. Funct. Mater., (2021) p. 2103936

Figures

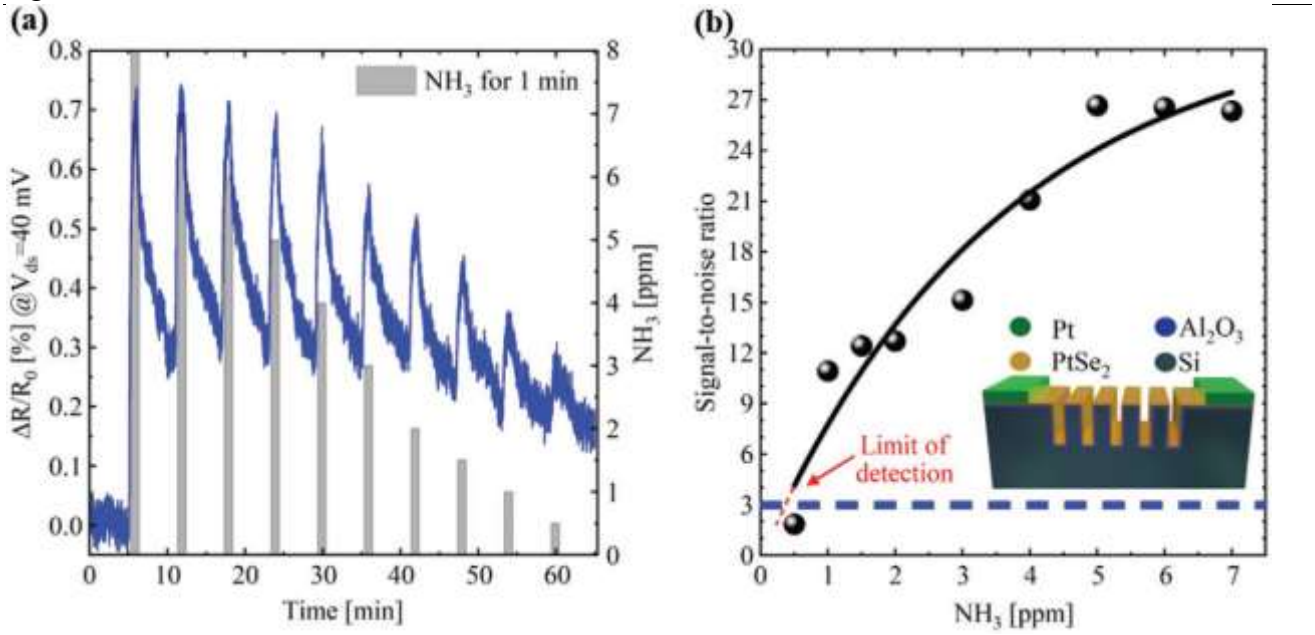

Figure 1: Structured $PtSe_2$ for NH_3 sensing. a) Fast sensor response at room temperature upon periodic declining NH_3 concentrations. B) SNR of sensor at various concentrations (dots). The fitted curve (black line) reveals a LOD of 370 ppb for NH_3. Inset: Schematic of the cross-section of the $PtSe_2$ gas sensor.