Wafer-scale two-dimensional semiconductors for deep UV photosensing

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Two-dimensional semiconductors (2SEM) provide an exciting material platform for science and technology. However, future advances require materials with engineered properties, methods to probe and manipulate these properties at the nanoscale, and integration technologies for their use in functional devices.

Here, we report on deep UV photodetectors based on wafer-scale high-quality GaSe, a 2SEM that can exist in different stoichiometries, crystal structures and layer stacking sequences [1]. Our use of a bespoke facility for the EPitaxial growth and In situ studies of 2SEM (EPI2SEM, see animation at https://bit.ly/3zN00dx) enables the precise engineering and study of a new centrosymmetric polymorph of GaSe [2] (Figure 1a). Its electronic and optical anisotropy are ideally suited to realize scalable UV sensors (Figure 1b) with prospects for a wide range of applications, including optical communication at UV wavelengths. Of particular interest is the 200-280 nm range of the UV-C band, which is free of solar background at ground level as solar radiation is absorbed by ozone in the upper atmosphere [3]. The large optical absorption of GaSe in the UV-C band under excitation with light polarized in the layer plane (Figure 1c) provides a platform for advances in this important technological spectral range.

References

[1] J. Srour et al. J. Chem. Phys. 149 (2018) 054106
[2] J.Grzonka et al. Adv. Funct. Mater. 31 (2021) 2104965
[3] D. Kaur et al. Adv. Optical Mater. 9 (2021) 2002160

Figures

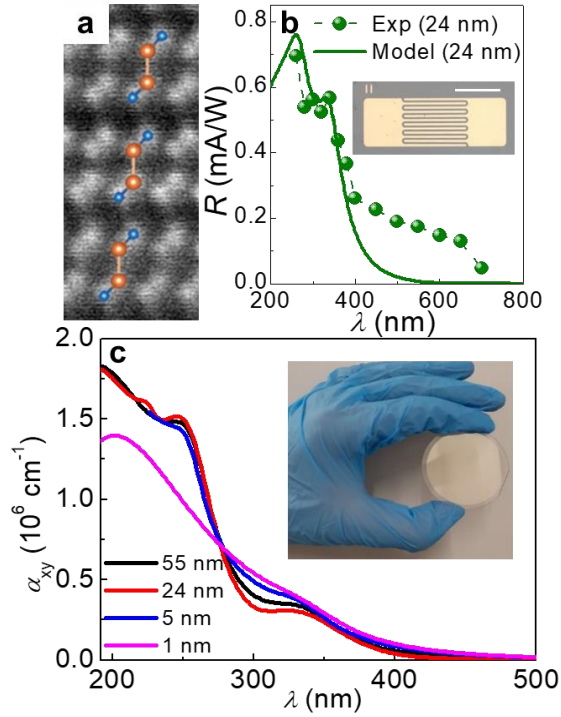

Figure 1a: Cross sectional TEM showing the centrosymmetric polymorph of GaSe. **b**: Measuerd and calculated photoresponsivity vs wavelength for a UV sensor based on GaSe, showing a peak in the UV-C band (260 nm). Inset: Image of the UV sensor with interdigitated gold contacts on GaSe (scale bar = 1 mm). **c**: Absorption spectra of GaSe films of different thicknesses (1 nm to 55 nm), as measured by ellipsometry. Inset: Image of wafer-scale GaSe on sapphire.