Contactless band gap measurements of 2D materials using LEIPS and UPS

Sebastian Klenk
George de Coster, Laura von Lüders, Cian Bartlam, Stefan Heiserer, Tanja Stimpel-Lindner, Georg S. Duesberg
University of the Bundeswehr Munich, Institute of Physics, Faculty of Electrical Engineering and Information Technology (EIT 2), Werner-Heisenberg-Weg 39, 85577 Neubiberg, Germany
sebastian.klenk@unibw.de, duesberg@unibw.de

To reliably and accurately determine the electrical band gap properties of two-dimensional (2D) materials, advanced analytical methods are highly sought after. However, commonly used techniques such as cyclic voltammetry or contact potential difference have limitations in their accuracy, particularly for small band gaps, or may cause chemical or thermal changes that can alter the properties of the material being investigated. As an alternative, a combination of Low Energy Inverse Photoelectron Spectroscopy (LEIPS) and Ultraviolet Photoelectron Spectroscopy (UPS) provides an accurate and non-invasive approach for measuring band gaps in thin films, including 2D material. Another very important advantage is the contactless nature of these measurements. In this work we investigated the electrical band gap of doped graphene functionalised non-covalently, as well as $PtSe_2$, which is frequently investigated for its outstanding sensitivity in sensor applications. Our results demonstrate that the band gap of $PtSe_2$ is dependent on the film thickness. Furthermore, we present new findings on the electrical properties of doped graphene.

References

[1] von Lüders, L., Tilmann, R., Lee, K. et al., Angew. Chem. Int. Ed., e202219024 (2023).

Figures

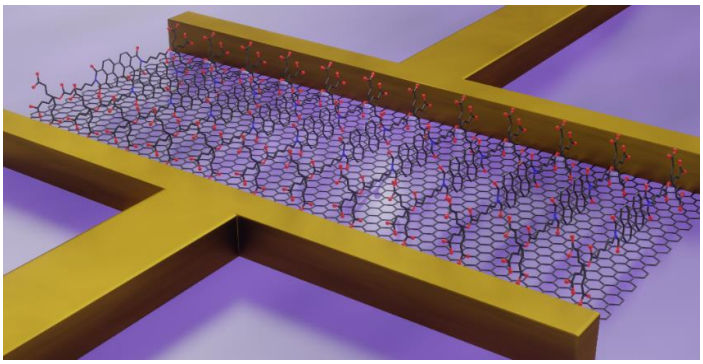

Figure 1: Schematic of a functionalized Graphene field effect transistor (GFET).[1]

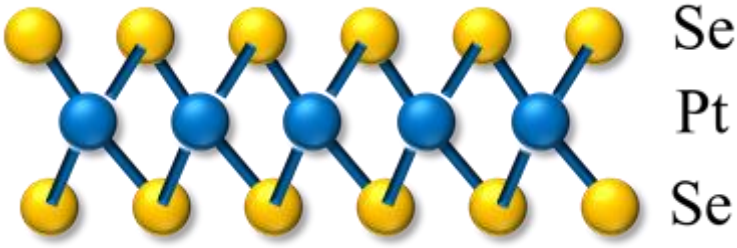

Figure 2: Single layer $PtSe_2$.