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Functionalisation Strategies of Monolayer Surfaces

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Two-dimensional (2D) materials such as graphene and transition metal dichalcogenides (TMDs) are intensively investigated because of their unique properties. The finding of thickness depend band gaps and high carrier mobility make them highly sought for fundamental studies and emerging applications in electronics. For most of those applications modification and passivation of the monolayers via functionalisation is a prerequisite. As the gas phase synthesis methods - preferable for electronical applications - yield substrate bound monolayers, wet-chemical functionalisation routes are somehow limited. In this presentation, various covalent and non-covalent routes are investigated to yield on-chip functionalisation of monolayer 2D materials. The graphene and TMDs films are grown by chemical vapor deposition CVD, which yields a high surface coverage with monolayers. The non-covalent functionalisation approach is via physisorption of perylene bisimide molecules from the liquid phase. As a result self-assembled monolayers (SAMs) through van der Waals interactions are created. By using a number of derivatives of perylene bisimides, well defined, stable surface functionalisation is realised.[1,2] Additionally, results on remote plasma treatments of graphene and MoS_2, introducing heteroatoms will be briefly presented.[3] The surfaces of the pristine and functionalised films are comprehensively are investigated by Raman spectroscopy, XPS, scanning probe techniques and TOF-SIMS. The effect on the electronic properties of the monolayer on FET structures are discussed.

References

[1] Berner, N. C. et al. Understanding and optimising the packing density of perylene bisimide layers on CVD-grown graphene. Nanoscale 7, 16337–42 (2015).
[2] Kim, H. et al. Optimized single-layer MoS2 field-effect transistors by non-covalent functionalisation. Nanoscale 10, 17557–17566 (2018).
[3] McManus, J. B. et al. Controlling Defect and Dopant Concentrations in Graphene by Remote Plasma Treatments. Phys. Status Solidi B 254, (2017).

Figures

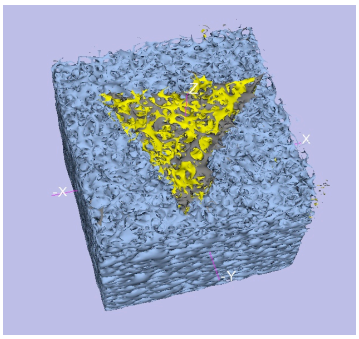

Figure 1: Elemental Composition of monolayer MoS_2 grown on SiO_2 investigated by TOF-SIMS