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Editorial: Optoelectronic Properties of Two-Dimensional Systems

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Editorial on the Research Topic

Optoelectronic Properties of Two-Dimensional Systems

Two-dimensional (2D) materials are emerging as the new frontier of research in solid state physics. The downscaling of electronic devices, in both size and energy consumption, passes through the improvement of fabrication techniques and the combination of 2D materials in van der Waals (vdW) heterostructures [1]. In recent years, more and more materials have been synthesized, whose very diverse properties have been analyzed with various techniques [2–4]. Stacking 2D materials together, and controlling the relative twist angle with an accuracy of less than a tenth of a degree [5], has opened an avenue for producing artificial materials with properties defined "on demand". The improvement and refinement of transfer techniques play a key role in determining the quality of the resulting vdW structure, and so do the ample progress made by the development of large-scale production techniques, such as chemical vapor deposition (CVD) [6].

The research topic Optoelectronic Properties of Two-Dimensional Systems presents some relevant contribution to the investigation of the optoelectronic properties of 2D materials and vdW stacks.

In the work of Zakharov, the properties of epitaxial graphene on 6H-SiC(0001) are described via low-energy electron microscopy (LEEM) measurements, under the condition of having one or two layers of Ge atoms intercalated at the heterointerface between graphene and SiC. Zakharov finds that Ge atoms on the second Ge layer diffuse much faster and so the mono-vs. bi-layer distribution can be controlled by temperature. In turn, this means that atomically sharp graphene *p*/*n* junctions can be realized in a controlled manner [7], opening the way for potential applications in pseudo-spin electronics and electron optics.

The article led by Prof. Flege et al. makes again use of LEEM and X-ray photoemission electron microscopy (XPEEM) to monitor the transition from one to two layers in MoS_2 grown on Au (111), showing the microscopic mechanism through which the second layer forms and providing valuable indications for synthetizing pure single layer molybdenum disulfide, a 1.83 eV direct bandgap semiconductor with remarkable optical properties.

In the article of Krause et al., the authors look at the quasiparticle dynamics in the bilayer WS_2/graphene vdW heterostructure. Time- and angle-resolved photoemission spectroscopy (Tr-ARPES) is a refined and powerful tool providing insightful information about the dynamics of transient states of the carriers excited from the valence to the conduction band. The authors use this technique to investigate the ultrafast charge transfer between graphene and WS_2, showing that the indirect nature of the bandgap in the WS_2 bilayer does not hinder the charge transfer mechanisms between the two 2D materials.

A relevant theoretical contribution to the description of the electron-phonon scattering is provided by the work of Narozhny and Gornyi, in which they model the supercollision mechanism in a regime of weak-violation of the energy conservation, showing that at very high temperature, supercollision represents the dominant decay channel.

The Optoelectronic Properties of Two-Dimensional Systems is therefore a Research Topic that touches multiple aspects of the 2D materials, from synthesis to structure, from optical to electronic properties and to theoretical modelling.

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AUTHOR CONTRIBUTIONS

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