van der Waals and Lateral Heterostructures of Organic and Inorganic 2D Materials: Synthesis and Device Applications

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van der Waals and lateral heterostructures of 2D materials open broad avenues for the engineering of novel nanomaterials for both basic research and applications. In particular hybrid heterostructures of organic and inorganic materials enable to combine their most attractive and complementary intrinsic properties (e.g., chemical functionalization, charge carrier transport, photo-response, etc.) into one material system with novel functionalities. In this presentation I will give an overview of our recent progress on the synthesis, characterization and device applications of such heterostructures composed of various 2D materials such as graphene, transition metal dichalcogenides, molecular nanosheets. It will be demonstrated how these innovative hybrid materials are employed in a variety of devices with advanced properties including phototransistors, chemical sensors, optical fibers for non-linear photonics, rectifiers, solar cells, photodetectors, ambipolar and anti-ambipolar transistors, and electroluminescent light emitters.

References

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[2] B. Zhao et al., 2D van der Waals heterojunction of organic and inorganic monolayers for high responsivity phototransistors. *Adv. Func. Mater.* 31 (2021) 2105444.
[3] D. Kaiser et al., pH Sensors based on amino-terminated carbon nanomembrane and single layer graphene van der Waals heterostructures*. Appl. Phys. Rev.* (2021) DOI: 10.1063/5.0040442.
[4] A. George et al., Giant persistent photoconductivity in monolayer MoS_2 field-effect transistors. *npj 2D Mater. Appl.* 5 (2021) 15
[5] I. Paradeisanos et al., Controlling interlayer excitons in MoS_2 layers grown by chemical vapor deposition. *Nat. Commun.* 11 (2020) 2391.
[6] G. Q. Ngo et al., Scalable functionalization of optical fibers using atomically thin semiconductors. *Adv. Mater.* 32 (2020) 2003826
[7] Z. Tang, A. George et al., Optically triggered control of the charge carrier density in chemically functionalized graphene field effect transistors. *Chem. Eur. J.* 26 (2020) 6473-6478.

Figures

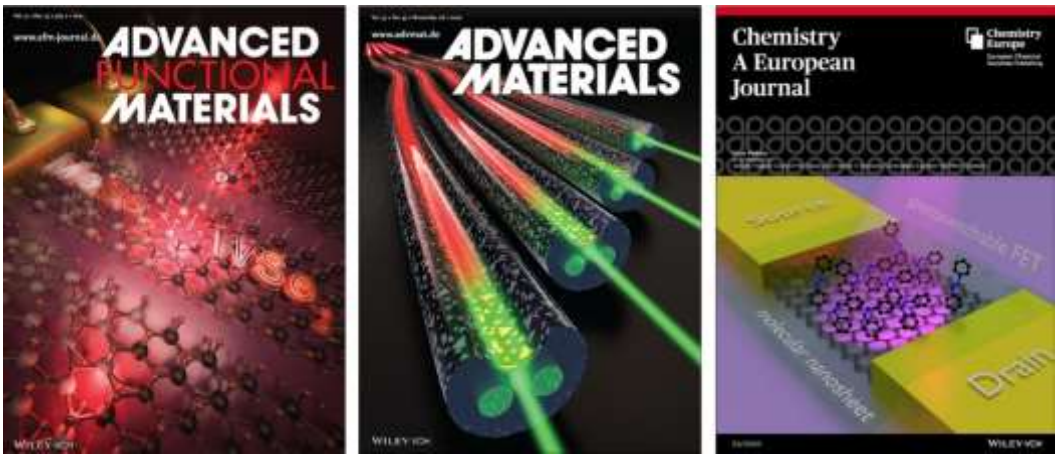

Figure 1: Cover artworks for Refs. [1] (left), [6] (middle) and [7] (right).