Graphene as substrate for selective self-assembly of 2-D materials for optoelectronic applications

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Graphene is well known as archetype of the 2-D materials, it is a multifaceted species widely recognized for a broad range of applications, including (opto)-electronics due to its outstanding ambipolar charge carrier mobilities and high transparency. These factors together with the highly ordered 2-D structure, makes graphene an ideal substrate for the growth of layered structures, enabling the assembly of heterostructures with graphene as the key step for the realization of complex hybrid device architectures. In optoelectronic applications, a proper electrical contact is critical for the optimal functioning of the device and graphene has been identified as a very efficient ambipolar charge carrier thus it is possible to use it as electrode. Recently, we achieved highly selective growth of PEDOT on patterned graphene, providing unique hole-conducting/electron-blocking heterostructures. This achievement tempted us to investigate the formation of other graphene heterostructures in a selective fashion and to explore their potential for (opto)-electronic applications. Here, we describe a highly efficient process of selective and oriented growth of various 2-D crystalline materials (optically active) on monolayer graphene. To achieve this we have chosen different organic precursors for the active material which is composed of alternated organic and inorganic layers. Varying the length of the aliphatic chain or size of the aromatic moiety (present in the organic part) affects the selectivity of film formation on graphene due to the hydrophobic interactions and/or π–π stacking, respectively. Thank to this, high spatial resolution down to 5 μm was achieved, as well as uniform coverage of up to centimeter scale graphene sheets.

References

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