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Epitaxial growth of graphene and 2D heterostructures on SiC for nanoelectronic applications

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Future applications of graphene in nanoelectronics will depend critically on the perfect control at the atomic level of its direct growth on semiconducting substrates and on the development of novel approaches to introduce a bandgap while preserving carrier mobility. Thermal decomposition of bulk SiC has proven to be an excellent method to grow transfer-free wafer-scale graphene, with the advantage of being perfectly integrated to the Si microelectronic industry fabrication process. Translating this to SiC/Si substrates is a promising but challenging route to decrease the costs. In this work we present results on two processes that are expected to lead to semiconducting 2D nanostructures based on graphene.

In the first process narrow SiC mesas, fabricated by patterning SiC/Si substrates using Focused Ion Beam (FIB) are annealed at 1250 °C in UHV. Synchrotron radiation spectroscopy and Scanning Tunneling Microscopy confirm the presence of free standing graphene on the nanostructures after hydrogen intercalation at 600 °C [1].

In the second process lateral graphene/h-BN heterostructures are grown by topological conversion of epitaxial graphene on bulk SiC, allowing the realization of semiconducting hybrid atomic layers with tunable properties. Boron and Nitrogen replace Carbon upon heated exposure of graphene to ammonia (NH_3) and boric acid (H_3BO_3) vapors: the concentration of h-BN can be controlled via the reaction time. The substitution of h-BN domains in the epitaxial graphene layer is confirmed by x-ray photoelectron spectroscopy (XPS) and scanning tunneling microscopy (STM), while Raman spectroscopy confirms that the reaction starts at defects sites.

[1] M.Amjadipour, et al., Nanotechnology, 29,145601 (2018)

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