Tunable bandgap in graphene induced by well-ordered H structures

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New materials derived from graphene allow carbon based 2D materials to be used in areas where the intrinsic properties of graphene would not be desirable. The simplest graphene derivatives obtained via chemical functionalization with atomic species such as hydrogen, oxygen and fluorine have already proved to be viable materials especially because of their high stability and interesting properties [1]. Typically functionalization with atoms changes the electronic and optical properties of graphene owing to the rehybridization of sp^2 carbon network into sp^3 one. In particular, the modification of graphene with hydrogen enables a variety of new phenomena to appear such as *e.g.* band-gap opening[2], enhanced spin-orbit coupling [3] and ferromagnetic order in single sided hydrogenated graphene [4]. The appearance of these phenomena, however, strongly depends on the type and size of hydrogen structures and their coverage [2,5,6]. The ability to control hydrogen structures on graphene, therefore, paves the way for future application of carbon based materials.
Previously we have shown that at RT and at low H coverage, the formation of hydrogen structures on a Gr/Ir(111) system follows the moiré superstructure, but the size and periodicity of these structures becomes quickly lost with increasing hydrogen dose [2,6]. In this work we show how one can force hydrogen structures to form a well ordered periodic pattern on Gr/Ir(111) over a macroscopically large area. Firstly, such controlled hydrogenation allows for tunable gap opening in graphene with much reduced carrier scattering as revealed by band dispersion analysis. Secondly, STM measurements show that only a single site of the moiré superlattice, namely hcp, can be hydrogenated under particular conditions, which consequently leads to a population of carbon atoms belonging to the same sublattice. Hydrogen structures formed this way may also induce magnetism in graphene.

References

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