

Substrate dependence in hydrogen-graphene interaction

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Theoretical and experimental studies have revealed that the properties of graphene can be changed substantially by hydrogenation. Theoretical calculations show that fully hydrogenated graphene, referred to as graphane, is an insulator [1] and that hydrogen line structures can induce graphene nanoribbon – like band gaps in graphene [2]. Experimental investigations reveal a change of electronic properties of graphene upon hydrogenation [3-6]. The experiments also show that graphene hydrogenation is substrate dependent [6-9]. Here we report on the substrate dependence of hydrogen adsorbate structures on graphene on SiC, Ir(111), Pt(100) and graphite.

Combined STM, TPD, DFT and XPS investigations of the interaction of graphene with atomic hydrogen reveal the formation of different types of hydrogen adsorbate structures on the graphene surface, depending on the degree and type of interaction between graphene and the underlying substrate. In the case of low substrate interaction, dimer like structures, similar to those displayed in figure 1.a. are observed, while in the case of a higher degree of interaction with the substrate, cluster structures with higher stability, similar to those displayed in figure 1.b. are observed. Furthermore, in some systems hydrogenation is observed to lead to increased graphene-substrate interaction.

In e.g. the graphene-Pt(100) system the graphene-substrate interaction is observed to be coverage dependent. At low coverage, hydrogen atoms are observed to form dimer structures similar to those observed previously on graphite, while, at higher coverage the reconstruction of the platinum substrate is lifted and more stable hydrogen adsorbate structures are observed. The experimental data indicate that the Pt substrate plays an active role in stabilizing these adsorbate structures on graphene.

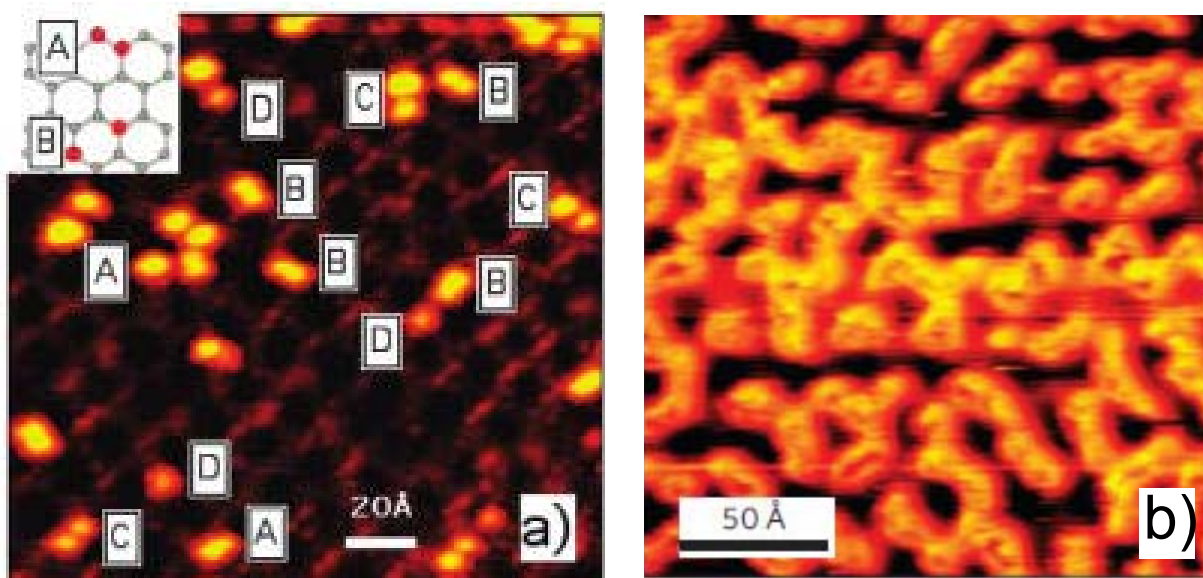
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Figures



a) Hydrogen dimer structures on graphene on SiC [8], b) Hydrogen clusters on graphene on Ir(111) [6].