Formation of graphene and hexagonal boron nitride on Rh(111) studied by in-situ scanning tunneling microscopy

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Propositions

accompanying the dissertation

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by

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1. The growth of graphene and the hexagonal boron nitride nanomesh structure on Rh(111) is discretized in the large unit cells of the moiré pattern between the lattices of the overlayer and the substrate. The growth process can be divided in two steps: kink creation and kink advancement with the unit cell of moiré pattern, with kink creation being the rate-limiting step.
   -- Chapter 4 & 11 of this thesis

2. The low-angle and translational domain boundaries in the nanomesh structure of hexagonal boron nitride cannot be removed by heating, even up to the temperature at which the nanomesh layer begins to disappear. Thus, the defect lines in this structure should be viewed as fossils of the initial configuration of nanomesh nuclei and their density directly reflects the nucleation density.
   -- Chapter 6 of this thesis

3. The initial nucleation stage during deposition of carbon on Rh(111) determines almost completely the form in which further carbon is incorporated – graphene or rhodium carbide. In the case of graphene growth, the initial stage also determines the orientations of the growing graphene patches.
   -- Chapter 8 of this thesis

4. Differences between the kink creation barriers at corners of graphene and on straight graphene edges result in different carbon adatom densities during graphene growth. This has an effect on the flux of carbon dissolving into or segregating out of the metal substrate.
   -- Chapter 11 of this thesis

5. One of the great advantages of an STM that has been developed for imaging surfaces during significant changes in sample temperature is that it has very low thermal drift during experiments at constant, high sample temperatures. Without the natural drift compensating character of such a special instrument, one would have to regulate the temperature of the sample with extreme accuracy and allow the STM to equilibrate for an extremely long time in order to enable STM measurement at high temperatures, as described in S. Günther et al. Nano Letters 11, 1895-1900 (2011).

6. The quality of graphene films grown on metal surfaces depends on a variety of parameters which often remain undetermined.

7. The growth rate of graphene on a metal surface depends not only on the carbon adatom density on that surface, but also on the number of carbon atoms in one moiré unit cell. McCarty et al., Carbon 47, 1806 (2009)

8. The temperature-programmed graphene growth method, in which precursor gas is deposited on the metal surface at room temperature after which the metal is heated, follows a very different reaction path than the direct dosing method, in which the clean metal surface is exposed to the gas at high temperature. This makes interpretations of the high-temperature growth process based on such low-temperature observations questionable. B. Wang, et al., Nano Letters 11,424 (2011)

9. One of the most effective ways to keep creative at work is to enjoy it. The way to keep effective at work is to experience a reasonable amount of pressure.