

Contrast Formation on Surfaces Composed of Hexagonally Arranged Carbon Atoms

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Hexagonally arranged carbon atoms are one of the most frequent structural units in nature. Examples are (i) graphene, i.e., a single sheet of carbon hexagons; (ii) graphite, i.e., ABA-stacked graphene layers; (iii) fullerenes in the form of tubes (rolled up graphene) or spheres (mixture of carbon hexagons and pentagons); and (iv) aromatic carbon rings, which are common in biological matter and synthesized organic molecules. The ability to resolve the atomic structure of carbon hexagons and to understand the contrast formation is therefore of major interest, particularly with respect to atomic scale investigations of biological systems.

From the above list graphite is the most often examined system. With force microscopy atomic scale contrast has been achieved in the static contact mode [1] and in the attractive [2] as well as repulsive [3] regime using the dynamic mode in vacuum. It turned out that data interpretation is not straightforward, because the ABA-stacking results in different A- and B-type carbon atoms, which then exhibit the same trigonal symmetry as the hollow sites. Recently, we succeeded to image single walled carbon nanotubes (SWNT) with atomic resolution using the dynamic mode in the non-contact regime (see Fig.1). As for graphite, a trigonal arrangement of protrusions is observed. However, in this case the carbon atoms are indistinguishable and the protrusions can be unambiguously assigned to the hollow sites. We will review the experimental results obtained on graphite with the different techniques (including scanning tunneling microscopy) and compare them to theoretical calculations and our results on SWNTs to get new insights into the contrast formation on compounds build up from carbon hexagons.

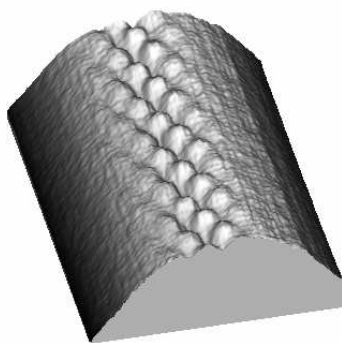


Fig.1: SWNT imaged with atomic resolution using the dynamic mode of SFM. The trigonal arrangement of the hollow sites is clearly visible on top of the curved nanotube.

[1] e.g., H. Hölscher et al., Phys. Rev. B **57**, 2477 (1998) and references therein.

[2] H. Hölscher et al., Phys. Rev. B **62**, 6967 (2000).

[3] S. Hembacher et al., Proc. Natl. Acad. Sci. USA **100**, 12539 (2003).