Application of dark-field LEEM imaging to observation of the nucleation and growth of C_{60} films on Bi(0001)/Si(111)

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The bonding of fullerenes to solid surfaces is often complicated, so phenomena such as charge transfer between substrate and adsorbate, chemical reactions, orientational ordering and reconstruction of adsorbate and/or substrate may be expected. Growth of epitaxial C_{60} films on silicon surfaces is of particular interest for technological reasons. However, the strong interaction between the C_{60} molecules and the clean Si surfaces induces film growth in the Stransky-Krastanov mode with only local ordering in the first monolayer. The passivation of the Si dangling bonds – for example with hydrogen – leads to van der Waals bonding of adsorbates and thus higher degree of crystallinity in C_{60} film, but the true relation between surface chemical and electronic properties, and the crystallinity of the fullerene film is not yet fully understood.

In this work, the C_{60} thin films were grown by ultra-high vacuum (UHV) deposition on Si(111) substrate covered with thin Bi(0001) passivation layer. Real-time, dark-field low-energy electron microscope (LEEM) investigation of the growth revealed that C_{60} film nucleates in fcc(111) phase, having an epitaxial relation with the Bi(0001) surface. At growth temperatures of ~400K, the preferential nucleation of C_{60} at the Bi twin boundaries was observed, but low-energy electron diffraction (LEED) confirmed that film had a single orientation and excellent crystallinity. The in-plane lattice parameter in the C_{60} films with thickness up to 3ML has been measured to be $|\mathbf{a}| = |\mathbf{b}| = 10.04 \pm 0.02$ Å, which is very close to the bulk value of 10.01 Å.

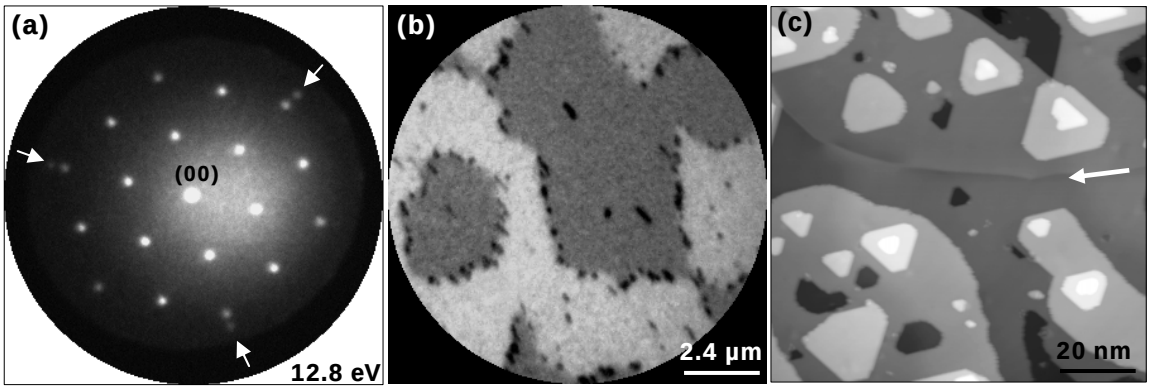

Fig.1. (a) LEED pattern taken from submonolayer C_{60} film on Bi(0001)/Si(111) surface; the spots originating from surface are marked by arrows; (b) dark-field LEEM image showing the twinned domains (light-grey and dark-grey) on Bi(0001) surface with superimposed bright-field LEEM image showing the preferential nucleation of C_{60} (black features) on the twin boundaries; (c) STM image showing the twin boundary (marked by an arrow) on Bi(0001).