Control of orientation of C_{60} monolayers using steps

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To improve the performance of devices using organic thin films, we have to be able to grow high quality films. Understanding the growth mechanism of the organic thin films would greatly contribute to this ability. For this purpose, we have been investigating the initial stages of epitaxial growth of C_{60} molecules on Si(111). In this work, we found that the orientation of the C_{60} monolayer can be controlled using steps on Si(111).

We grew C_{60} molecules on nominally flat and vicinal Si(111) surfaces at the substrate temperature of about 400 K. Before the C_{60} growth, we deposited Au on the surface to form the 6x6 structure. Single-layer steps and multilayer steps existed on the nominally flat and vicinal surfaces, respectively. The structure of the C_{60} layers was investigated using low-energy electron microscopy (LEEM) and low-energy electron diffraction (LEED).

Figure 1 shows a LEEM image after the C_{60} deposition on the vicinal Si(111) surface misoriented 2 degrees to the <11-2> direction. Straight lines running almost vertically are multilayer steps, and two-dimensional C_{60} islands seen as dark patches nucleate along the steps. Figure 2 shows a contrast-reversed LEED pattern after further deposition of C_{60} on the same substrate. The diffraction spots from the substrate are indicated by dotted circles. The other spots originating from the C_{60} monolayer constitute a triangular lattice, indicating that all the C_{60} islands have the same orientation. Several domains with different orientations nucleate on the nominally flat and <1-10>-misoriented vicinal Si(111) surfaces. The height and direction of the steps are the keys to controlling the orientation of the C_{60} monolayer.

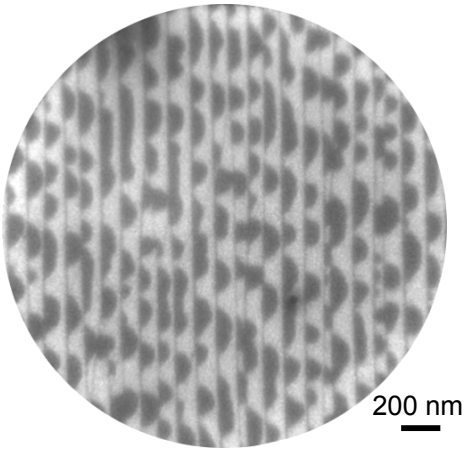

Fig. 1. LEEM image after C_{60} growth on vicinal Si(111) misoriented 2 degrees to <11-2>. The electron energy is 10 eV.

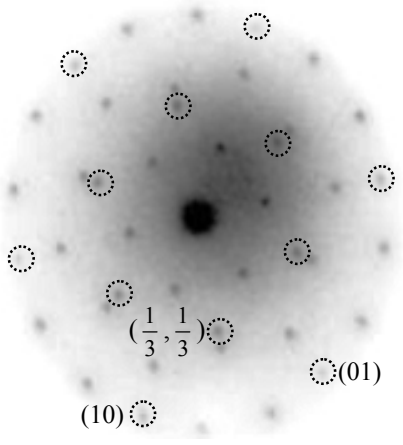

Fig. 2. LEED pattern after C_{60} growth on vicinal Si(111) misoriented 2 degrees to <11-2>. The electron energy is 15.2 eV.