Origin of the bimodal island size distribution in ultra-thin films of para-hexapheny on mica

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PACS numbers: 68.37.Ps, 68.43.Jk, 68.43.Vx, 68.55.A-, 68.55.am, 81.15.Aa

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Abstract

Ultra-thin films of para-hexaphenyl (6P) were prepared on freshly cleaved and on sputter amorphized mica(001) by physical vapor deposition (PVD). Ex-situ atomic force microscopy (AFM) revealed a bimodal island size distribution for the films on both surfaces. On freshly cleaved mica long needle like islands exist, which are surrounded by small crystallites. On the sputter amorphized substrates, large dendritic islands exist which are again surrounded by small, compact islands. We could prove by thermal desorption spectroscopy (TDS), that the small islands are the result of adsorbate induced subsequent nucleation, when the films were exposed to air. In case of the freshly cleaved mica, islands grow on a wetting layer in vacuum. This layer dewets and forms the small islands upon venting, due to the adsorption of water. In case of the amorphous mica substrate an equilibrium exists between the islands and a 2D gas phase in the sub-monolayer regime. Again, the latter phase nucleates after venting. In a particular coverage range, islands due to nucleation during deposition and subsequent nucleation coexist on the substrate, leading to the bimodal island size distribution. Kinetic Monte Carlo (KMC) simulations were performed to model the nucleation process after venting on the sputter modified mica substrate. The density of the subsequently nucleated islands just depends on the initial coverage and the critical island size. A critical cluster size of $i = 7$ molecules was determined for 6P on amorphized mica, by comparing the KMC results with the AFM images in case of adsorbate induced nucleation. Furthermore, the experimentally obtained island size distributions could be well reproduced by KMC simulations.