AlF_3 growth on Cu (100). A new kinetically driven growth mechanism.

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Abstract.

The growth of ultrathin epitaxial layers of aluminum fluoride on Cu(100) has been studied by a combination of surface science techniques. Deposition at room temperature results in step decoration followed by the formation of dendritic two-dimensional islands that coalesce to form porous films. Ultrathin layers (up to 2 monolayers in thickness) are morphologically unstable upon annealing; de-wetting takes place around 430 K with the formation of three-dimensional islands and leaving a large fraction of the Cu surface uncovered. Films several nanometers thick, on the contrary, are stable up to ca. 730 K where desorption in molecular form sets on. The effect of electron irradiation on the AlF3 has also been characterized by different spectroscopic techniques; we find that even small quantities of stray electrons from rear electron beam heating can provoke significant decomposition of the aluminum fluoride, resulting in the release of molecular fluorine and the formation of deposits of metallic aluminum.

From the basic point of view, STM measurements reveal several interesting facts at low coverages, like quite large diffusion path lengths, nucleation at both sides of steps, and small island nucleation along preferential directions. Based on Monte Carlo simulations and Density Functional Theory calculations, we propose a new diffusion model based on kinematic properties. This new mechanism breaks the isotropic features of random adatom diffusion over a single crystal surface, not only about the main directions but also about the sense of movement. This mechanism allows us to understand all the anomalous growing features on the AlF3/Cu[001] system.