Formation of water ice clusters on graphite

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The process of surface wetting and formation of ice structures on surfaces have been studied extensively. Beyond being of great importance within the field of surface technologies [1], it may also govern freeze-out mechanisms in the interstellar medium (ISM) [2]. In cold regions of the ISM icy mantles exist on the surface of interstellar dust grains. These may act as a heterogeneous catalysis system where adsorbed molecules may interact, sometimes mediated by photon irradiation, to form large and complex molecules [3]. Structural differences of water ice, which are detectable in IR-spectroscopy [4], will have an impact on the interaction between complex molecules in the ice, e.g. for adsorption and diffusion characteristics [5]. The structure of the water ice mantle depends on the thermal history and will differ depending on formation conditions.
Here we examine water ice formation on highly oriented pyrolytic graphite (HOPG) in the sub-monolayer regime using a low-temperature scanning tunnelling microscope (LT-STM) functioning at 5 K. Sub-monolayer amounts of heavy water (D_2O) were deposited onto an HOPG surface kept at ≈ 40 K. Presented in Figure 1 is water ice clusters grown at 40 K via molecular deposition on the HOPG surface. A clear diffusion limited aggregation (DLA [6]) growth is visible from the fractal structure of the clusters, both near step edges and for individual nucleation sites. Only 2D growth is observed at these sub-monolayer coverages. DLA leads to low densities and an amorphous and porous structure which with growth may form the reputed amorphous solid water of icy grain mantles. Finally, we investigate how an oxygen functionalised O-HOPG surface may influence the already complex growth of water ice clusters on interstellar grain analogues, offering a unique look into non heat-treated water ice clusters.

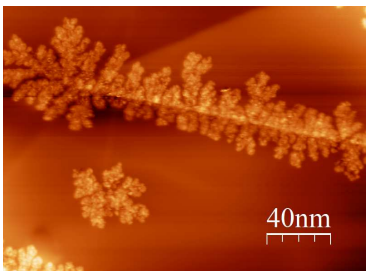

Figure 1: LT-STM image of water ice clusters on HOPG (4.5 V, 15 pA)

References

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