In-situ observation of heterogeneous nucleation of ice by ultrahigh-vacuum transmission electron microscope

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Ices are ubiquitous in space. Crystallinity of ice is important to discuss the evolution of icy grains or icy bodies, because physical properties of amorphous and crystalline ices differ some orders of magnitude. However, there has been almost no systematic study investigating crystallinty of ices heterogeneously condensed on refractory grains at 80-150 K. Therefore, we observed heterogeneous nucleation of ices on some substrates at 80-145 K using ultrahigh-vacuum transmission electron microscope. We used following substrates: a-Mg_2SiO_4, organic refractory residue, a-C, a-Si and crystalline Al.
We found that at higher temperatures large islands of crystalline ice Ic were formed, and that with decreasing temperatures size and numbers of islands becomes smaller and larger, respectively. At temperatures below critical temperatures, uniform amorphous thin films were formed. The critical temperature on crystalline substrate (Al) is around 100 K, while those on amorphous substrates 125-130 K. These experimental results show the necessity of reinvestigation on the discussion of crystallinity of ices condensed in space (Kouchi et al., 1994) and collision-sticking process of icy grains.

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