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Identification of ice nucleation active sites on K-feldspars: extension to immersion freezing

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Ice formation on aerosol particles is a process of crucial importance to Earth's climate and the environmental sciences, but it is not universally understood at the molecular level. Recently, we have identified the unique features on potassium-feldspar responsible for its high ice nucleation efficiency (Kiselev et al., 2016). We have used environmental scanning electron microscopy combined with atomistic modeling to investigate the deposition nucleation of ice on the crystalline surfaces of various feldspars. In that study, the microscopic patches of (100) surface, exposed at surface defects such as steps, cracks, and cavities have been identified as the ice nucleating active sites (INAS). We have hypothesized that these surface features should be universally active in any heterogeneous freezing mode. In this contribution, we present an experimental evidence that this is indeed the case for the immersion nucleation of ice on the surface of potassium feldspar (microcline). Additionally, we address the question of a strong variability of ice nucleation efficiency of alkali feldspars by using the energy dispersive X-ray spectroscopy (EDX) and IR spectroscopy sensitive to the surface hydroxyl groups. Using a combination of analytical methods, we have compared two specimens of potassium feldspar different in their chemical and structural heterogeneity. Here, we report a strong correlation between the stability of hydroxyl groups on the mineral surface and its ice nucleating efficiency.

Kiselev, A., F. Bachmann, P. Pedevilla, S. J. Cox, A. Michaelides, D. Gerthsen and T. Leisner (2016). "Active sites in heterogeneous ice nucleation—the example of K-rich feldspars." Science doi: 10.1126/science.aai8034.