

A variable temperature liquid AFM and observation of morphological changes of an ice-like structure on mica

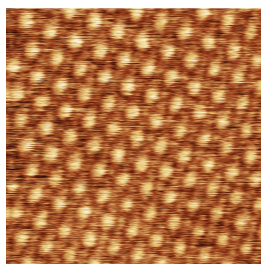
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We have built a variable temperature liquid AFM [1] with atomic resolution. The temperature range of the liquid cell was -10 °C to 100°C. When imaging mica in pure water with the torsional mode, morphological changes of Å to nm deep features could be observed below 15°C. The features changed with temperature and time. Due to the relatively large depth of the features and their changing nature, we ascribe them not to the surface of mica itself, but structures formed on its surface, such as an ice-like structure.

Immersing the mica sample in pure water for one or two days also had a drastic effect on the appearance of the acquired images. As a general tendency, the force corrugation increased after a day of immersion of the sample(Fig1), where as, immersion of the tip for more than two or three days generally deteriorated the apparent image quality, though a “noisy” image does not necessarily mean that the tip is bad, but rather that there is a decrease in the marked periodicity of the force corrugation. A fluctuating ice like structure was once imaged with the AFM but difficult to reproduce. From finding with the new variable temperature AFM, though further verification is needed, such fluctuating features at the molecular level may be captured by immersion of mica for a day or two, and imaging around



15°C, where ‘melting’ of a 1.5 Å thick monolayer on mica was observed.

Figure 1. High force corrugation imaged after a days immersion of mica in pure water. Imaging by torsional mode, amplitude of drive ca 1 Å.

References

- [1] Shuhei Nishida, Dai Kobayashi, and Hideki Kawakatsu, *J. Vac. Sci. Technol. B* 27, 964 (2009).