Atomic resolution in the attractive and the repulsive regime by frequency modulated atomic force microscopy on MgO at 5K

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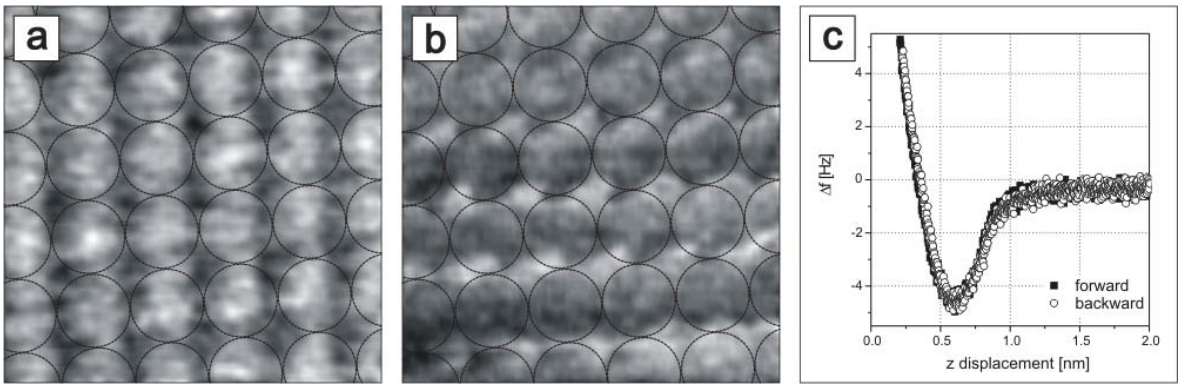
Here we present atomically resolved frequency modulation atomic force microscopy (FM-AFM) images performed on an ionic surface (MgO on Ag(100)) by using small oscillation amplitudes. The shown experiments have been obtained in ultrahigh vacuum at a temperature of 5K using a home-built double tuning fork sensor [1].
Frame (a) shows a high-resolution constant frequency shift controlled image acquired in the attractive mode (Δf=-3.7Hz), while frame (b) the same area imaged in the repulsive mode (Δf=+3.7Hz). A grid indicates the position of equivalent ionic species. The switching between the attractive and the repulsive mode has been performed on purpose by adjusting the frequency shift set point. This experiment has been repeated several times and the obtained data has always shown the same conversion in the imaging contrast. The contrast formation of ionic surfaces is well known for FM-AFM imaging in the attractive mode. However, FM-AFM images in the repulsive mode have only been reported for CaF_2 so far [2].
The contrast formation in the repulsive mode is rather complicate. Even though the tip is oscillating with certain amplitude, the tip sample distance always stays in the repulsive, contact like, regime (frame c) and the tip sample interaction is dominated by the repulsion between the surface and tip ions. Due to a more complex inward displacement, a lateral in-plane distortion of the surface ions should be considered, when the repulsive force between the tip and surface is originated. At such a close approach the situation becomes even more complicated due to substantial deformation of atoms both at the tip end and at the surface underneath it. Elastic tip and sample deformations with a stick-slip type movement are likely to contribute to the imaging contrast [3].



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