NC-AFM observation on cleavage surfaces of the mixed alkali halide crystal

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The importance of NC-AFM study on the insulator surfaces as well as the semiconductor surfaces arises with an expectation of manipulating the single atoms and assembling the artificial nanostructures on insulator surface to realize the future atomic devices. For alkali halide crystals as one of the insulators, it is easy to prepare the atomically flat and clean surface by simply cleaving both in air and in vacuum. In this experiment, we have observed $KCl_{0.9}I_{0.1}$(100) mixed crystal surface [1] by NC-AFM as a pre-research on the manipulation and assembly on the insulator surfaces.

The NC-AFM experiment was carried out in ultra-high vacuum at room temperature, and the constant amplitude mode was used for oscillating the Si cantilever. Atomically flat and clean surface of $KCl_{0.9}I_{0.1}$(100) was prepared by cleaving the single crystal in air, followed by quick transfer to the vacuum system within 30 minutes and heating at 200°C for 1 hour (heat treatment was performed case by case).

Figure 1 shows the typical topographic NC-AFM images of the cleavage surface of the pure KCl(100) (Fig. 1 (a)), and the mixed KCl(100) with KI 10% (Fig. 1 (b)). The periodic atomic structure was revealed with little defect in Fig. 1 (a). On the other hand, Fig. 1 (b) exhibits the peculiar atomic structure, where several darker spots exist like defects. This darker spots would be caused by the I^- impurities because of the quantitatively different defect amounts in comparison with the pure KCl(100). However the precise diagnosis of these defects based on quantitative and qualitative approach is necessary for a further manipulation process on the ionic crystal surface.

In this work, we present the experimental results of observing the atomic structure on the mixed alkali halide, and discuss nature of the atomic defect and possible identification of individual ionic species, considering the various experimental factors such as the tip apex, the cleavage surface preparation and heating conditions.

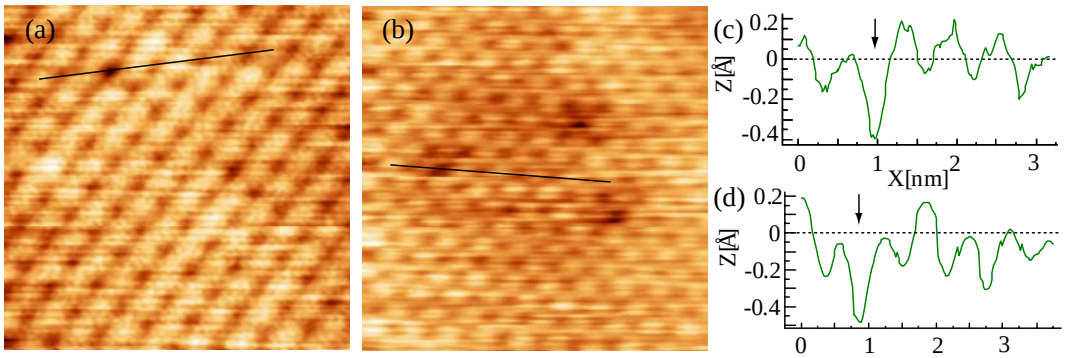

Fig.1.(a) Topographic NC-AFM image of the cleavage surface of the pure KCl(100) single crystal (4.6nm×4.6nm, Δf= -76.3Hz, A_0= 27Å), (b) topographic NC-AFM image of the cleavage surface of the KCl+KI(10%) mixed crystal (5.9nm×5.9nm, Δf= -90.8Hz, A_0= 15Å), (c) the line profile of the (a), (d) the line profile of the (b)

[1] The $KCl_{0.9}I_{0.1}$ single crystals were provided by Prof. Tadashi Itoh in Osaka University.