NC-AFM study on atomic defects formed on ionic crystal surface by nanoindentation

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Recently, the remarkable results of noncontact atomic force microscopy (NC-AFM) study prove its capability of being a powerful tool to identify and manipulate individual atoms vertically and laterally on Si(111), Sn/Si(111), and Sn/Ge(111) surfaces. Manipulating selective atoms on insulating surfaces such as ionic crystals provides a way to assemble insulator atoms toward future electronic devices. In this experiment, we have investigated atomic structure on alkali halide surface and artificial atomic defect formed on the surface by nanoindentation.

The KBr(100) clean surface was fabricated by cleaving the single crystal in air, moving the sample immediately to the preparation chamber in UHV, and heating at 420ºC for 1 hour.

Figure 1(a) shows the topographic NC-AFM image before creating the atomic defect, which was acquired in a normal operating condition (frequency shift Δf of –284 Hz). The observed surface was the defect free and atomically flat with the lattice constant of 6.60 Å, slightly distorted owing to the thermal drift. After the artificial atomic defects were created by the nanoindentation (with the value increased to Δf : +60%, damping: +8%), it should be noted that the artificially peeled-off second layer surface was atomically resolved on the surface as shown in Fig.1(b). From the feature of the defects, it could be considered both K^+ ion and Br^- ion were simultaneously extracted. In the other case, the second layer could not be atomically resolved even though the atomic defects were formed on the surface as shown in Fig.1(c). Although we do not know which ion, K^+ ion or Br^- ion, was extracted from the surface, we conjecture in this case that only a part of ions was removed.

In this study, we investigate the two types of artificial atomic defects created by the nanoindentation on the KBr(100) surface.

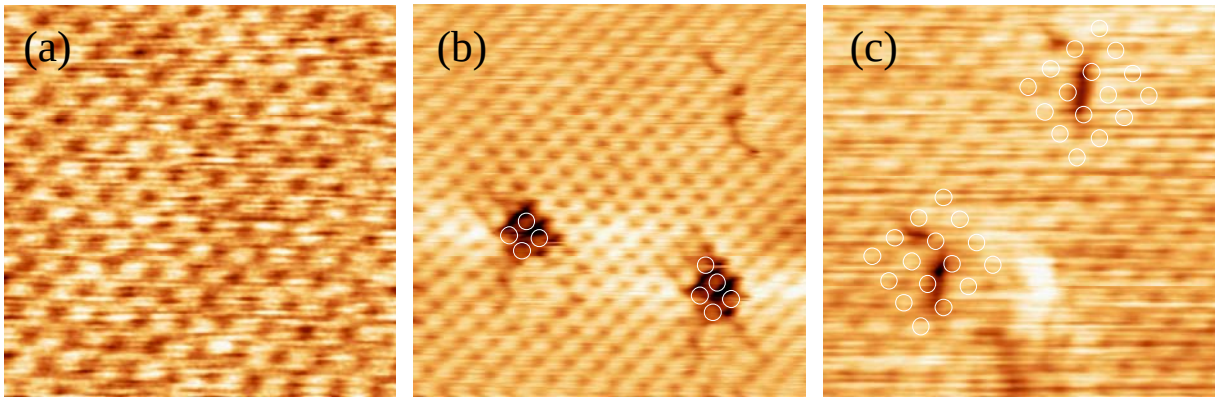

Fig.1 The topographic NC-AFM images of KBr(100) cleavage surface. (a) The defect free surface before the nanoindentation (A_0=20 Å, Δf=-284Hz, 63 Å×53 Å), (b) one type of atomic defects formed after the nanoindentation (A_0=20 Å, Δf=-273 Hz, 85 Å×73 Å), (c) the other type of atomic defects formed after the nanoindentation (A_0=20 Å, Δf=-275 Hz, 63 Å×53 Å)