Interchange Manipulation of Sn and Ge atoms on Ge(111)-c(2x8) at 80K

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A novel interchange lateral manipulation method of Sn and Ge adatoms on the Ge(111)-c(2x8) surface at room temperature using non-contact atomic force microscopy (NC-AFM) has been reported [1,2]. Using this method, the "S" and "n" letters composed by 19 substitutional Sn atoms were assembled. The two kinds of atoms are identified because Sn adatoms are higher than Ge adaoms in topography (Fig.1(a)).

To perform the interchange manipulations, one-dimensional scans above the line connecting the center of the Sn and Ge adatom was used; then tip and sample were gradually approached by changing the set point of the frequency shift for the height feedback. The interchange was recognized by the change of the positions of the two corresponding topographic signals. This method is well controlled but the detail of the interchange manipulation mechanism and the process has not been clarified yet. At room temperature, not only the short-range interaction force between tip and surface plays a decisive role but also the thermal activation has to be taken into account in these processes.

In this contribution, we will show relevant experimental results regarding the interchange manipulation mechanism obtained at low temperature. At 80K, due to a considerable reduction of the thermal energy, the short-range interaction force could be considered the dominant driving phenomenon. We have observed that the Sn adatoms occupied intermediate metastable-like positions on the surface as shown in Fig. 1(b). These experimental results show that, decreasing the tip-surface distance, the Sn adatoms seems to be more movile than the Ge adatoms. More relevant information obtained from topography and dissipation signals related with the interchange manipulation will be discussed.

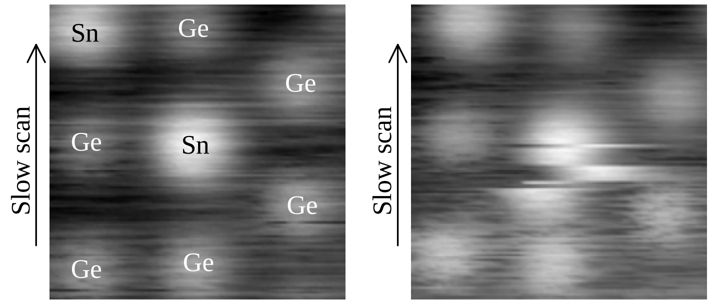

Fig. 1. (a) Δf = -13.4 Hz (b) Δf = -14.2 Hz
Image size : 2.0 x 2.0 nm^2

[1] Y. Sugimoto et. al., Nature Mater. **4**, 156 (2005)
[2] N. Oyabu et. al., Nanotechnology **16**, S112 82005)