Room-temperature lateral manipulation of the Si(111)-(7×7) adatoms

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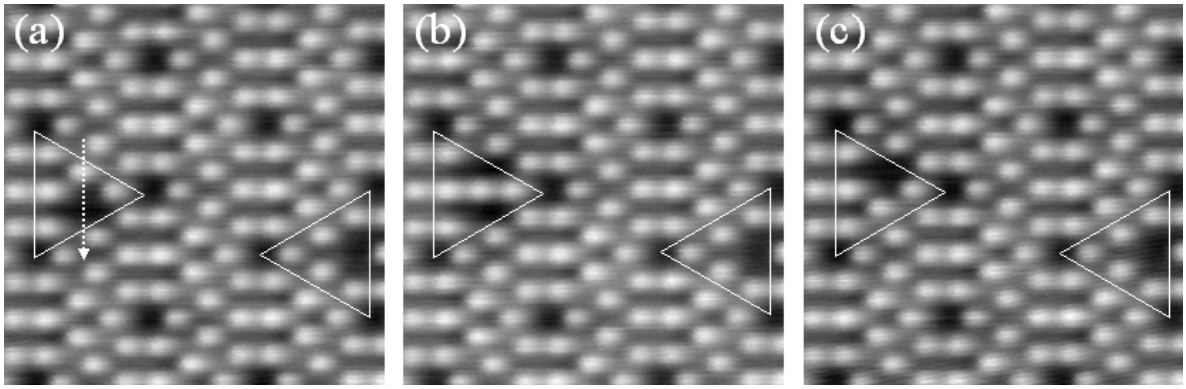
Recently, we have demonstrated lateral atomic manipulation and assembly using non-contact atomic force microscopy (NC-AFM) at room temperature [1]. Nevertheless, more experimental information is required for a further understanding of these processes. The manipulation mechanism is related to the chemical interaction between the tip-apex atoms and the surface atoms. The Si-Si chemical interaction force between the adatoms of the Si(111)-(7×7) surface and the atoms of a Si tip apex is relatively well understood by force spectroscopic measurements [2] and first principle calculations [3]. Therefore, we have investigated lateral atomic manipulations of single adatoms of the Si(111)-(7×7) surface, mediated by the presence of an atomic vacancy, at room temperature.

The figures show NC-AFM topographic images of a series of manipulations of a Si adatom. In these images, there are two atomic vacancies in two different half unit cells indicated by the white triangles; the one on the left was used as open space for manipulating Si adatoms and the other was used as a marker. One of the center Si adatoms (figure (a)) was laterally manipulated in the direction of the white arrow and displaced to a new quasi-stable site (figure (b)). Then, the same Si adatom was manipulated toward the opposite center adatom site (figure (c)). The manipulations were performed by successive vector scans of the tip in the direction indicated by the white arrow. Although the vacancies on the Si(111)-(7×7) surface do not diffuse at room temperature, Si adatoms can be manipulated not only across the half-unit cell but also parallel to the dimer-rows (figures are omitted). Relevant information obtained from the analysis of line profiles during the manipulation processes and force spectroscopy will be discussed.



[1] Y. Sugimoto, M. Abe, S. Hirayama, N. Oyabu, O. Custance, and S. Morita, Nature Materials **4**, 156 (2005).
[2] M.A. Lantz, H.J. Hug, R. Hoffmann, P.J.A. van Schendel, P. Kappenberger, S. Martin, A. Baratoff and H.-J. Guntherodt, Science **291**, 2580 (2001).
[3] R. Perez, M.C. Payne, I. Stich and K. Terakura, Phys. Rev. Lett. **78**, 678 (1997).