FM-NCAFM study of heat-treated oxide substrates with organic molecules

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The concept of using organic molecules as components of various electronic devices has been put forward as a promising way of overcoming the various constraints imposed by silicon-based device technologies. Further developments in this area require greater fundamental knowledge of the physical and chemical properties of organic molecules. In particular, the conformational features of individual molecules on surfaces must be elucidated with sufficient spatial resolution to coordinate complex and functional supra-molecular structures with individual molecular units on substrates.

Frequency modulation non-contact atomic force microscopy (FM-NCAFM) is a versatile tool for this purpose because of its ability to access insulating substrates without touching the surface. This feature is important because, in many cases, we have to treat conductive nano-scale objects on insulating substrates for device designing. However, there are few reports of successful observation of individual large organic molecules using FM-NCAFM with sufficient spatial resolution on insulating substrates. One reason for this is the difficulty to control the mobility of individual molecules on the surfaces.

We previously presented the novel concepts of controlling the mobility and conformation of large organic molecules on a substrate by appropriately tuning the interactions between the molecules and substrates by means of chemical modification of the molecules, and succeeded in visualizing the conformational features using FM-NCAFM at sub-molecular resolution [1,2] on the metal surface. The next step is to extend the application of these concepts to the molecules on insulating surfaces by exploring various materials [3].

In this talk, we report the experimental results of FM-NCAFM observations of the nano-meter scale features of insulating surfaces produced by oxidation treatments on various oxides, and discuss their physical properties and affinity to organic molecules under UHV condition.

[1] S.Tanaka, H.Suzuki, T.Kamikado, S.Mashiko, Nanotechnology **15** (2004) 87.
[2] S.Tanaka, H.Suzuki, T.Kamikado and S.Mashiko Thin Solid Films **438-439** (2002) 56.
[3] S.Tanaka, H.Suzuki, M.Inada, T.Kamikado, S.Mashiko, Nanotechnology **16** (2005) 107.

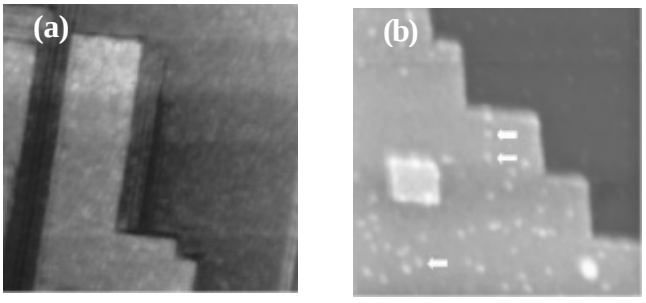

Figure (a) shows an FM-NCAFM image of the surface of single crystalline $SrTiO_3$(100) heat-treated in oxygen gas. Figure (b) shows an FM-NCAFM image of the same surface on which very small quantities of porphyrin-based molecules were dispersed. Some bright spots corresponding to individual molecules are indicated by white arrows in the figure. Image sizes are 100nm x 100nm and 80nm x 80nm, respectively.