Simultaneous measurement of local contact potential difference and density of state on Au/TiO_2(110) surface by KPFM/STM

Department of applied physics, Osaka University

°**Huanfei Wen, Ryosuke Kanbayashi, Masahide Suesada, Yanjun Li and Yasuhiro Sugawara**

E-mail: hfwen@ap.eng.osaka-u.ac.jp

Rutile TiO_2(110) surfaces supported Au nanoclusters have been extensively used to investigate the mechanism of the CO oxidation reaction since it has extremely high catalytic reactivity [1]. On TiO_2 surface, defects significantly play an important role for the adsorption of Au nanoclusters and catalytic reaction process. And the electron charge transfers from Au nanoclusters to TiO_2(110) [2]. However, the charge state of the Au nanoclusters and the reaction process are not clarified and the questions such as what the mechanism of O_2 dissociation is, where the reactive site is, etc., haven't been answered yet. Furthermore, the local contact potential difference (LCPD) with atomic resolution hasn't been obtained on TiO_2(110) surface. In this study, we simultaneously measure LCPD and the density of state of Au nanoclusters with atomic resolution by Kelvin probe force microscopy (KPFM) and scanning tunneling microscopy (STM).

Experiments were performed with the homebuilt low temperature FM-KPFM under ultrahigh vacuum (UHV) condition. The rutile TiO_2(110) surface was cleaned by the cycles of Ar ion bombardment and subsequent annealing at 900K. After the clean TiO_2(110) surface was obtained, Au atoms was deposited on the surface. As a probe, the commercial Ir-coated Si cantilevers were chosen.

In the LCPD measurements, the method of the FM-KPFM without bias voltage feedback was used to remove the effect of phantom force [3], and the LCPD images were obtained at the constant height mode to remove the crosstalk of the surface topography.

In the KPFM/STM experiment, the DC bias added with ac bias voltage was applied between the tip and the sample. Two lock-in amplifiers were used to measure frequency shift at f_m and f_{2m}. The CPD signals were numerically calculated from the divided result of the two frequency shift signal. The z-dependent of $V_{\mathrm{LCPD}}(z)$ curve and STS curve on the same point were investigated by FM-KPFM without bias voltage feedback.

Experimental data will be reported in the meeting.

References:

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