Platinum Particles on TiO_2(110) Observed by a Scanning Kelvin Probe

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Chemical reactions in industry are often catalyzed on nanometer-sized particles of transition metals, which are interfaced with a metal oxide support. The electron transfer from the particles to the support, or vise versa, is thought to control the reactions. In the present study, nanometer-sized Pt particles were vacuum-deposited on a rutile TiO_2(110) surface. The lateral distribution of the work function was mapped by a scanning Kelvin probe (JSPM4500A, JEOL) to deduce the electron transfer of individual particles.

Our talk at Seattle (2004) was focused on single Pt adatoms dispersed over this atomically flat support; the electron transfer form an adatom to the support creates an electric dipole moment pointing to the vacuum and locally reduces the work function. This is analogous to what we observed on a Na-deposited TiO_2 surface [1].

More platinum was deposited in the present study to simulate nanometer-sized metal particles working on industrial catalysts. Figure 1 shows the topography and work function of a surface modified with Pt particles. The work function still decreased on particles suggesting an electron transfer to the support.

The lateral diameter (d) and the work function decrease ($\Delta\phi$) were determined on each particle. An example of cross sections is shown. Thereby Observed $\Delta\phi$ was proportional to the square of d. This relationship is presentd in Fig. 1 and interpreted with the assumption that a constant number of electron is transferred per unit interface area. A simple simulation to estimate the absolute number of transferred electron is now examined.

[1] A. Sasahara, H. Uetsuka and H. Onishi, Jpn. J. Appl. Phys. 43 (2004) 4647.

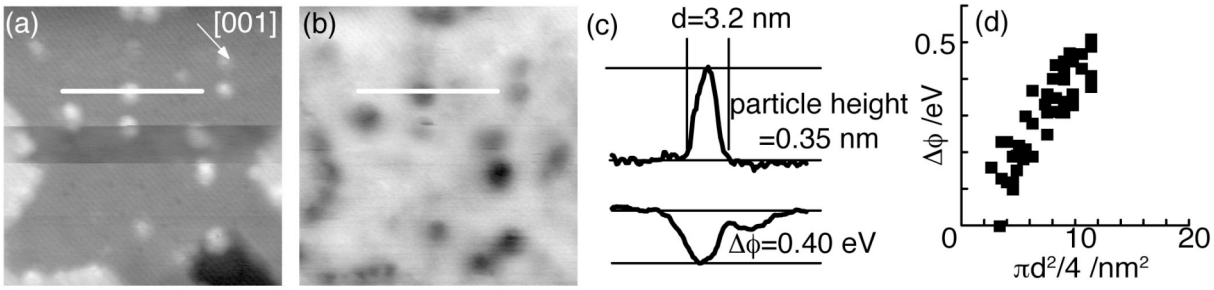

Figure 1 The constant frequency-shift topography (a) and work function map (b) of a TiO_2(110) surface modified with vacuum-deposited Pt particles. Image size: 30x30 nm^2, frequency shift: -58 Hz, scanning rate: 1.7 s per line. The cross sections observed on a particle are shown in (c). The reduction of work function (df) determined on many particles is plotted in (d) as a functions of the Pt-TiO_2 interface area.