Local work function of Au/TiO$_2$ model catalysts measured by Kelvin probe force microscopy

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Since Au is chemically very stable and it does not lose metallic luster even after long term exposure to air, Au had been regarded as being catalytically inert. In 1987, Haruta and co-workers have discovered that Au nanoparticles, supported on metal oxides, exhibit novel catalytic activity such as low-temperature CO oxidation. The catalytic activity of Au is strongly dependent on the particle size and the kind of metaloxide supports, which suggests that the nano-sized interface between Au and supports plays an important role for the activity. In order to clarify this nano-hetero interface effect, experimental and theoretical researches have been performed on the Au/TiO$_2$ model catalyst.

Among them, the STM research by Goodman et al. is important [1]. They discovered the correlation between the activity and the quantum size effect (QSE) of Au particles. Taking into account the importance of extra electrons, we considered that this phenomenon is related to the charge distribution at the Au/TiO$_2$ interface. Therefore, we have performed local barrier height (LBH) measurement by STM and found that the QSE is correlated with work function difference (WFD) between Au particles and a TiO$_2$ substrate [2,3]. However, since LBH measurement is strongly influenced by the tip condition (e.g. work function, structure), it was difficult to evaluate the charge distribution at the interface quantitatively.

In this research, we performed CPD measurement by Kelvin probe force microscopy (KFM), and estimated the WFD and the charge density on the Au/TiO$_2$ model catalysts. Figure 1 shows the size dependence of CPD of the Au nanoparticles. The CPD gradually increases with the size of Au. On the other hand, the size dependence of LBH is different from that of CPD. We consider this difference is caused from the difference in size dependence between electrostatic interaction and electron tunneling.

References