Strong metal-support interaction: A case study on TiO$_x$/Pt(111) for CO oxidation

Mingshu Chen, Huan Li, Xuefei Weng, Ding Ding, Hong Zhang, Huilin Wan

State Key Laboratory of Physical Chemistry of Solid Surfaces, National Engineering Laboratory for Green Chemical Productions of Alcohols–Ethers–Esters, Department of Chemistry, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen 361005, Fujian, CHINA.

Since the strong metal-support interaction (SMSI) effect was first described in 1978 by Tauster, a great deal of effort has been carried on for preparing efficient catalysts and understanding its mechanism. For the metal / titanium oxide system, most of the spectral and morphological evidences showed that the presence of Ti$^{3+}$ plays a key role in SMSI. Encapsulation of TiO$_x$ on metal nanoparticle has been evidenced. Moreover, well-ordered TiO$_x$ thin films have been reported to be prepared on single crystal surfaces. In this presentation, an improved method for measuring the turnover frequency (TOF) for a catalytic reaction on a single crystal surface is proposed. Different types of TiO$_x$ thin films with various coverages are prepared on the Pt(111) surfaces to mimic the SMSI interface. The fully cover of the Pt(111) surface by TiO$_x$ films at 1 ML is confirmed by home-built wide spectral range infrared reflection absorption spectroscopy (IRAS) using CO adsorption as a probe, in which only very weak CO adsorption peak is observed. CO catalytic oxidation is tested on these model surfaces. Significant enhancement is observed at submonolayer region. The high catalytic activity can be maintained for many cycles. And the stability of these model SMSI surfaces is confirmed by in-situ IRAS as shown in Figure 1.

Figure 1. (A) and (B) In-situ IRAS spectra for CO oxidation on the 1 ML TiO$_x$/Pt(111) surface.

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