Bi-functional element Fe for CO RT oxidation in Pt-Fe catalyst

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The oxidation of carbon monoxide is not only playing an important role as model reaction in fundamental research of catalysis, but also has practical applications of multiple fields. The catalysts that combine Pt with Fe or other transition metals would present better performance, which is still lacking the exact or concerted descriptions about active sites and reaction mechanism of CO oxidation [1-5]. The surface science studies could be effective to get a better understanding of CO oxidation at room temperature. The experimental work was taken in an UHV system with three separate chambers of sample preparation, spectroscopy analysis of XPS/UPS/ISS and microscope of STM, at the base pressure of 1.0-3.0×10^{-10} mbar.

A novel model catalyst of Pt-Fe alloy, designated as FtFe/Fe/Pt(111) in Fig. 1, has been developed for CO oxidation at room temperature, which was observed to finish less than 30 minutes in 1.3×10^{-8} mbar O_2, by using time-programmed ultraviolet photoelectron spectroscopy (with He II light, 6 L CO preadsorbed, shown in Fig. 2). The FtFe/Fe/Pt(111) catalyst could tune the chemical activity of the previously reported Ft/Fe/Pt(111) model further with a small amount of surface Fe atoms to enhance O_2 adsorption selectively. Subsurface Fe atoms in Pt-Fe alloy could weaken the adsorption of both CO and O_2 significantly by tuning the surface electronic properties, however, a small amount of surface Fe atoms would enhance O_2 adsorption selectively and make the strength of O_2 adsorption become moderate. The adsorption strength of CO and O_2 have been well balanced on PtFe/Fe/Pt(111) surface and made it possible for CO oxidation at room temperature.

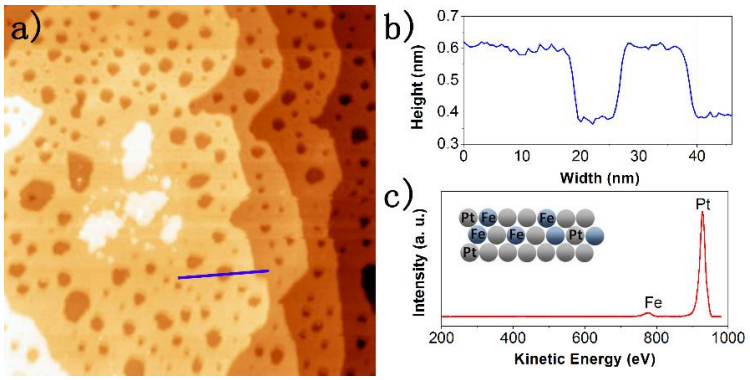

Fig.1 Structure of PtFe/Fe/Pt(111) surface: a) STM image, 400 ×400 nm^2; b) line profile at the position marked in a) as the blue line; c) ISS spectra (inset, schematic drawing of surface structure).

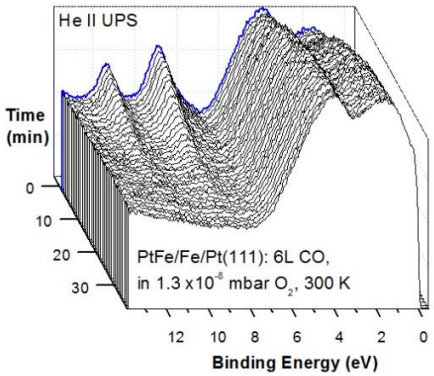

Fig.2 UPS spectra of PtFe/Fe/Pt(111) surface (6.0 L CO) being exposed to 1.3×10^{-8} mbar O_2 gas stream at room temperatre (300 K).

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