

## The structures and catalytic activities of metallic nanoparticles on mixed oxide

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The metallic nanoparticles (Pt, Au, Ag, Cu, etc.) supported on ceria-titania mixed oxide exhibit a high catalytic activity for the water gas shift reaction ( $\text{H}_2\text{O} + \text{CO} \leftrightarrow \text{H}_2 + \text{CO}_2$ ) and the CO oxidation ( $\text{O}_2 + 2\text{CO} \leftrightarrow 2\text{CO}_2$ ). It has been speculated that the high catalytic activity is related to the easy exchange of the oxidation states of ceria ( $\text{Ce}^{3+}$  and  $\text{Ce}^{4+}$ ) on titania, but very little is known about the ceria titanium interaction, the growth mode of metal on ceria titania complex, and the reaction mechanism. In this work, the growth of  $\text{CeO}_x$  and  $\text{Au/CeO}_x$  on rutile  $\text{TiO}_2(110)$  have been investigated by Scanning Tunneling Microscopy (STM), Photoelectron Spectroscopy (PES), and DFT calculation. In the  $\text{CeO}_x/\text{TiO}_2(110)$  systems, the titania substrate imposes on the ceria nanoparticles non-typical coordination modes, favoring a  $\text{Ce}^{3+}$  oxidation state and enhancing their chemical activity. The deposition of metal on a  $\text{CeO}_x/\text{TiO}_2(110)$  substrate generates much smaller nanoparticles with an extremely high activity. We proposed a mechanism that there is a strong coupling of the chemical properties of the admetal and the mixed-metal oxide: The adsorption and dissociation of water probably take place on the oxide, CO adsorbs on the admetal nanoparticles, and all subsequent reaction steps occur at the oxide-admetal interface.