Growth and Structures of Metal Dopant-Ceria Mixed Oxide Interfaces

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Ceria has been widely studied as an oxidation-reduction catalyst due to its unique redox properties and oxygen storage capacity [1]. The addition of other metal elements such as Ti and Mn into ceria could better enhance its thermal stability and improve its redox properties and oxygen storage capacity. To understand the chemistry of doped-ceria mixed oxides, it is of crucial importance to determine their surface structures at the fundamental level. We present our study on the growth of ceria thin films with Ti and Mn dopants and the understanding of their structures using X-ray photoelectron spectroscopy, low-energy electron diffraction, as well as scanning tunneling microscopy. Well-ordered CeO_x(111) with controlled degree of Ce reduction and atomic structures can be prepared on a Ru(0001) single crystal substrate [2]. Metal-doped ceria mixed oxide interfaces were prepared by depositing Ti or Mn over CeO_x(111) thin films. Co-deposition of Ce with metal dopants can produce well-ordered $Ce_{1-x}M_xO_{2-\delta}$(111) mixed oxide films (M=Ti, Mn) [3]. Dopant types and compositions can influence the surface structures, electronic structures, and redox properties of ceria. Effects of Mn and Ti dopants in ceria were investigated for Ni as steam reforming of ethanol catalysts for energy production. Compared to pure ceria, addition of metal dopants in ceria can provide unique anchoring sites and interaction for deposited Ni, which can significantly stabilize Ni as small metal nanoparticles upon heating. Additionally, modified structures and electronic properties of ceria by dopants offer alternative adsorption and reaction sites and provide promotional effects in the resistance of the coke formation over deposited Ni nanoparticles in the adsorption and reaction of ethanol. The research is sponsored by the National Science Foundation (Award Number: CHE1151846).

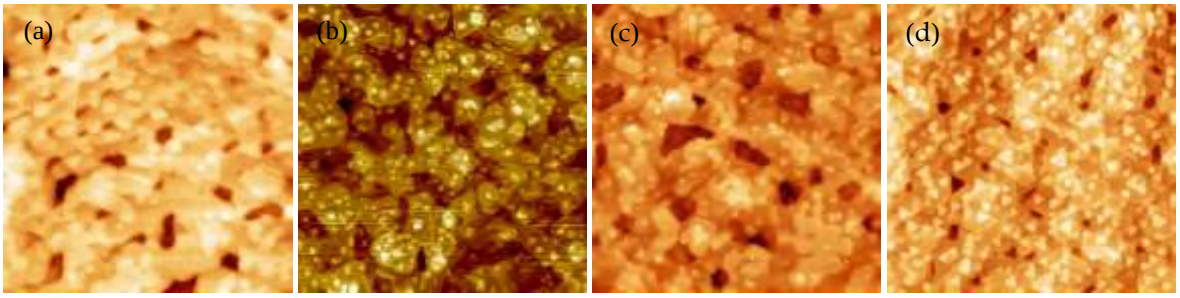

Figure 1 STM images of (a) $Ce_{0.94}Mn_{0.06}O_{1.91}$ and (b) MnO-CeO_x, (c) and (d) $Ce_{0.94}Mn_{0.06}O_{1.91}$ and MnO-CeO_x upon deposition of 0.25 ML Ni at 300 K and heating to 800 K. Image sizes are 100 nm × 100 nm.

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