Understanding Oxidations Reactions on Pt-Re Surfaces: NAP-XPS and Reactor Studies

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Methanol and CO oxidation have been investigated on Pt-Re bimetallic surfaces in order to understand how the addition of Re promotes activity on Pt in alcohol reforming and other oxidation reactions. Pt-Re alloy surfaces were prepared by depositing Re on Pt(111) or polycrystalline Pt foils and annealing to 1000 K. Scanning tunneling microscopy studies demonstrate that the deposited Re islands diffuse into the Pt(111) surface upon annealing, and low energy ion scattering studies indicate that the top monolayer close to 100% Pt. XPS investigations were carried out during oxidation reacctions at pressures of 300-550 mTorr, and gaseous products were monitored using a mass spectrometer. CO oxidation experiments demonstrate that under reaction conditions, CO desorbs more readily from the Pt-Re alloy surface compared to pure Pt. Methanol oxidation was studied on clean Pt(111), the Pt-Re alloy and Re films grown on Pt before and after surface oxidation at 450 K. The main products on all surfaces were CO_2 and H_2O with formaldehyde, CO and H_2 as minor products. The presence of Re in the Pt-Re alloy prevented accumulation of carbonaceous residues on the surface at higher temperatures and also suppressed the shift in selectivity from CO_2 to CO. The diffusion of Re to the surface of the alloy at elevated temperatures is believed to facilitate dissociation of O_2. These results are compared with methanol oxidation studies in a flow reactor (P=760 Torr) coupled to the ultrahigh vacuum chamber.