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In-situ microscopy and spectroscopy for structural and catalytic studies

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Abstract content

Over the last decades my laboratory has developed and applied microscopy and spectroscopy techniques for in situ studies of the surface structure of catalysts in the presence of various gases. These include high pressure Scanning Tunneling Microscopy (HP-STM), in situ x-ray spectroscopies using Synchrotron radiation. These include high pressures x-ray absorption (XAS) and X-ray photoelectron spectroscopy (HP-XPS). We applied these techniques to the study of various reactions and surfaces on single crystals and nanoparticles. I will illustrate the capabilities of these techniques with several examples. These include the restructuring of Pt single crystals in the presence of CO, the structure of Rh(111) in the presence of CO and NO, the determination of the surface phase diagram of Pd oxides in equilibrium with O2, and others. In the area of nanoparticles, I will show the application of XAS and HP-XPS to study the structure and activity of Co nanoparticles for CO+H2 methanation as a function of particle diameter from 3 to 20 nm. The particles Co were found to remain metallic and covered by CO during reaction. The reactivity per Co atom was found to decrease when the particle size became smaller than 10 nm, an effect that was related to the decreased activity of the particles to dissociate H2, while the rate limiting step did not change. Using HP-XPS also we observed the structural modifications of core-shell Rh-Pd and Rh-Pt alloy nanoparticles during oxidative and reducing conditions.

Summary

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