Structural Evolution of an Intermetallic Pd-Zn Catalyst Selective for Propane Dehydrogenation

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A Pd-Zn alloy supported on Al_2O_3 is a selective catalyst for propane dehydrogenation. In situ synchrotron X-ray diffraction (XRD), diffuse-reflectance infrared Fourier transform spectroscopy (DRIFTS) and extended X-ray absorption fine structure (EXAFS) were used to follow the structural changes with increasing reduction temperature. EXAFS shows that a bimetallic nano-particle forms at about 230°C and the number of Pd-Zn bonds increases with reduction temperature. DRIFTS shows a change from bridge to linear bonded CO at 230°C; while there was little change in the surface of the nanoparticles when reduced above 325 °C. XRD indicates that the β_1-PdZn intermetallic alloy forms at reduction temperatures as low as 230 °C, likely first at the surface, but does not form extensively throughout the bulk until 500 °C. The improvement in the propane dehydrogenation selectivity is suggested to be due to isolation of the active metallic Pd atoms by inactive metallic Zn atoms.