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Structural and Catalytic Investigation of Palladium-Gallium Intermetallic Compounds

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Palladium constitutes an important catalyst for hydrogenation and for combustion reactions. Typical Pd-catalysts are supported on metal oxides and show high activity but only limited selectivity. The limited selectivity of Pd catalysts may be caused by neighbouring active sites on the catalyst. Binary intermetallic compounds (IC) PdGa and Pd_3Ga_7 are particularly interesting as potential catalysts because of the isolation of the Pd atoms in the structure. In both structures the Pd atoms are surrounded by a coordination sphere of Ga atoms. This significant difference in the local structures of Pd metal clusters and the Pd-Ga IC permits to tailor the selectivity of palladium catalysts in hydrogenation reactions.
The thermal stability of PdGa and Pd_3Ga_7 in various atmospheres was investigated by in situ XAS, in situ XRD, and thermal analysis. Catalytic studies were carried out for oxidation and hydrogenation reactions and the surface area was determined by BET measurements and CO adsorption. The structural evolution of PdGa and Pd_3Ga_7 in helium, hydrogen, and oxygen in the temperature range from 293 to 773 K shows that the Pd-Ga ICs are stable under these conditions. Catalytic studies show activity for propene and ethylene hydrogenation, for CO oxidation as well as high selectivity for acetylene hydrogenation to ethylene.