Hydrogen uptake in Palladium nanoparticles : The effect of stabilizer and the structure on the hydrogen absorption behaviour

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Abstract

In this work the hydrogen uptake in 3.7nm Pd nanoparticles will be presented. Two samples were prepared using the same preparation parameters but different stabilizers, : First, icosahedral Pd clusters stabilized in Tetraoctylammonium bromide (TOAB) surfactant. Second, cubic Pd clusters stabilized in tetraoctylphosphonium bromide (TOPB). Size and structural determination of these nano-sized particles will be presented. The characterization was done using X-ray diffraction (XRD), High Resolution Transmission Electron Microscopy (HRTEM) and Extended X-Ray Fine Absorption Structure (EXAFS).

The phase transition during hydrogen uptake in these samples was monitored by in situ X-ray diffraction. It will be shown that the hydrogen uptake ability depends strongly on the lattice structure which is affected by the type of stabilizer. The TOPB stabilized clusters (cubic clusters) show the phase transition which is common for bulk Pd, whereas the surfactant stabilized clusters (icosahedral clusters) show only weak lattice dilatation upon hydrogen absorption. Pressure-lattice parameter Isotherms show that, the cubic clusters absorb large amounts of hydrogen in comparison with the icosahedral clusters. The measured lattice expansion is 0.130Å at 105 Pa and 300 K, which is about 320% the amount measured for icosahedral clusters (0.04Å). This suggests that surface sites are available for hydrogen in the Pd-TOPB samples which are not accessible for Pd-surfactant-clusters, and that the icosahedral lattice absorbs less hydrogen for similar external pressures.

Keywords: Clusters; Surfactant; nanostructures; X-ray diffraction, Synchrotron radiation