Synthesis of Nano-Meter-Sized Core-Shell Bimetallic Magnesium-Palladium Clusters and Their Hydrogen Uptake Capacity

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Abstract

In this work, the synthesis of magnesium and palladium core-shell bimetallic clusters (MgPd CSC) was performed with combined salt reduction-electrochemical technique by using a simple electrolysis cell. The as-prepared clusters were characterized by using FT-IR, SEM, TEM, XRD, EDX, AAS and UV-Vis spectroscopy to probe clusters' surface, size, structure, shape, morphology, and optical properties, respectively. The hydrogen storage capacity of the as-prepared clusters was investigated from both points of view "thermodynamic and kinetic" by using gravimetric and volumetric techniques.

The characterization of the as-prepared clusters confirms the success in preparation of core/shell bimetallic clusters with Mg- rich core and Pd-rich shell with fcc crystalline structure and size near to mono-distribution and ranging from 1.5-4.5nm, which increases as the current density decreases or the concentration of Mg-core increases. The optical properties of the as-prepared clusters were performed by using UV-Vis spectroscopy, which shows a blue shift for the surface plasmon resonance with lowering the ratio between Pd-shell and Mg-core. The band gap energy (E_g) of clusters was calculated and found to be core to shell size dependent in the range (3.0-3.3 eV). As-prepared clusters show a large enhancement "approximately 2 folds" for the hydrogen storage capacity either of Pd and Mg/Pd clusters that reported in literatures, with reliable kinetics and reversible absorption-desorption processes. In which, the cluster sample with size ca. 3.5 nm and metallic stoichiometry of Mg_1Pd_3formula absorbed the maximum

amount of hydrogen (ca. 1.22 wt%) at ambient conditions "1bar and 25°C" within few minutes and desorbed all amounts of absorbed hydrogen again, effectively within absorption time.