# Hydrogen storage in nano-sized metallic and bimetallic clusters

Mohammed Suleiman
An Najah National University, Nablus, Palestine

**Abstract**

The physical and chemical properties of low dimensional nanometer sized materials, such as nanocrystalline materials and clusters, are of particular interest because they are often size dependent and different to bulk properties [1,2]. With decreasing the size of the clusters to the nano-range the number of surface atom to volume is increased and their properties become size dependent.

Metallic clusters are used intensively in catalysis reactions such as Hydrosilylation, isomerization and hydrogenation reactions. In the case of Palladium clusters and its alloys, hydrogen can be absorbed in internal sites of the clusters [2, 4]. The palladium-hydrogen system is thus in a special way is suited for the investigation of physical properties of binary alloy systems at the smallest scale.

In this work the hydrogen solubility in different metallic clusters with discrete sizes have been investigated. Surfactant and polymer stabilized clusters, which are tension-free stabilized and have a narrow size distribution, have been prepared. Their crystallographic structure is a function of cluster size between the icosahedral and the cubic. The critical cluster size for the structural change was found to be about 4.8 nm for quasi-free stabilized Pd clusters. In this work the thermodynamic absorption behaviour of hydrogen in nano-meterd-sized metallic clusters with different sized and different structure have been determined from gravimetric and volumetric solubility isotherms. The phase transition in these samples was monitored by in situ X-ray diffraction measurements during hydrogen loading. Preliminary studies have already shown that the phase boundaries and the hydrogen uptake ability in these samples depends strongly on the lattice structure which is affected by the type of metallic clusters and the stabilizer used in samples, and that the phase diagram of Pd-H system for small cluster is strongly different from that of the solid material [3,4,5].

In this paper comprehensive picture on the effect of the size and the structure on the activity and hence on the hydrogen absorption in the low dimension system will be presented.

**References**

[1] H. Haberland (Ed.) Clusters of atoms and molecules, Springer-Verlag Berlin Heidelberg 1994.
[2] **M. Suleiman**, C. Borchers, M. Guerdane, N. M. Jisrawi,D. Fritsch, R. Kirchheim , A. Pundt, Z. Phys. Chem. **223** (2009) 169-181.
[3] **M. Suleiman**, J. Faupel, C. Borchers, H.-U Krebs, R. Kirchheim and A. Pundt J. Alloys Compd 404-406(2005)523
[4] **M. Suleiman**, N. M. Jisrawi, O. Dankert, M. T. Reetz, C. Bähtz, R. Kirchheim, A. Pundt, J. Alloys Compd. 356-357 (2003) 644
[5] C. Nützenadel, A. Zütel, D. Chartouni, G. Schmid, L. Schlapbach, Eur. Phys. J. D. **8** (2000) 245