Abstract #2651, 224th ECS Meeting, © 2013 The Electrochemical Society

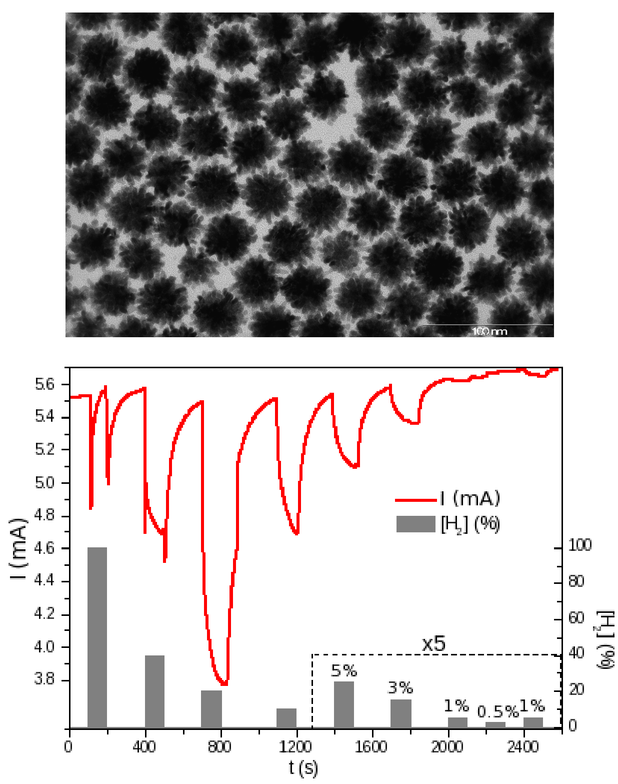
Hydrogen resistivity sensors from nanoparticle assembles: palladium versus platinum.

Khalil Rajouâ and Frédéric Favier

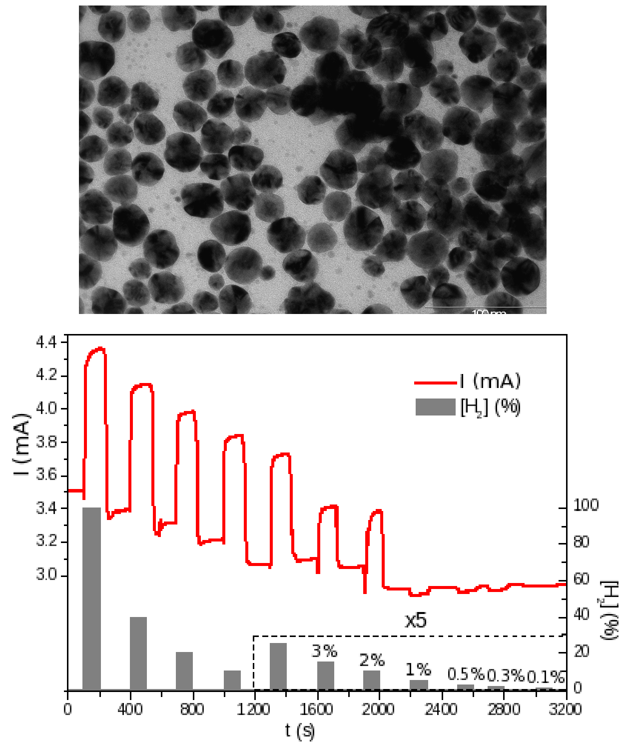
Institut Charles Gerhardt Montpellier
UMR 5253 CNRS Université Montpellier 2
34095 Montpellier cedex 05
France

The goal of the present study is the design and fabrication of resistive hydrogen (H_2) sensors for safety purpose. Most of the existing H_2 sensors include Pd as sensing material since its reactivity towards H_2 induces, thanks to the reversible formation of palladium hydrides, drastic changes in the chemical and physical characteristics of the sensing element: work function, light absorption, electronic conductivity, Young modulus, volume...[1] Despite a different reactivity towards H_2, Pt can also be used for H_2 sensing [2]. In modern H_2 sensors, these metals are used as nanostructured materials for an increase in the developed surface area resulting in an enhancement of the sensing capabilities.

Nanostructuration also leads to a greater tunability of the sensor design and sensing performances (detection and temperature ranges, cross-sensitivity...) but also to sensing mechanisms sometimes difficult to assign [3-5].



TEM image of Au@Pt core-shell nanoparticles 2D array and the corresponding sensor response in current (red) versus H_2 concentration in air (grey). Voltage bias at 0.5V



TEM image of Au@Pd core-shell nanoparticles 2D array and the corresponding sensor response in current (red) versus H_2 concentration in N_2 (grey). Voltage bias at 0.5V

In the present study we have built 2 and 3D assembles of Pd or Pt -based nanoparticles and evaluated their electronic conductivity in presence of H_2/N_2 or H_2/air gas mixtures for the purpose of efficient resistive H_2 sensing. Raw Pd or Pt nanoparticles were prepared using various chemical routes as well as Au@Pd or Au@Pt core-shell nanoparticles. These nanoparticles were assembled by various techniques, including surface grafting, dip casting, Langmuir-Blodgett deposition... at the surface of glass substrates on which interdigitated gold electrodes were initially deposited by lithography techniques to allow electrical measurements.

Depending on the particle composition, the topological characteristics of the assembles and the composition of the hydrogenated gas mixture, various sensing responses were observed in terms of sign (conductivity increase or decrease), amplitude, and response and recovery times. Sensing performances are discussed towards the characteristics of the fabricated sensors and the phenomena arising at the particle surface consequently to the dissociative adsorption of H_2.

References

1. Hübert, T., et al., *Hydrogen sensors–a review.* Sensors and Actuators B: Chemical, 2011. **157**(2): p. 329-352.
2. Yang, F., et al., *The Surface Scattering-Based Detection of Hydrogen in Air Using a Platinum Nanowire.* Nano letters, 2012. **12**(6): p. 2924-2930.
3. Favier, F., et al., *Hydrogen sensors and switches from electrodeposited palladium mesowire arrays.* Science, 2001. **293**(5538): p. 2227-2231.
4. Villanueva, L.G., et al., *Highly ordered palladium nanodot patterns for full concentration range hydrogen sensing.* Nanoscale, 2012. **4**(6): p. 1964-1967.
5. Fournier, C., et al., *Palladium–Silver Mesowires for the Extended Detection of H2.* ACS applied materials & interfaces, 2013. **5**(2): p. 310-318.