Hydrogen resistivity sensors from nanoparticle assemblies: palladium versus platinum.

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The goal of the present study is the design and fabrication of resistive hydrogen ($\text{H}_2$) sensors for safety purpose. Most of the existing $\text{H}_2$ sensors include Pd as sensing material since its reactivity towards $\text{H}_2$ 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 $\text{H}_2$, Pt can also be used for $\text{H}_2$ sensing [2]. In modern $\text{H}_2$ 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].

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 $\text{H}_2/\text{N}_2$ or $\text{H}_2/\text{air}$ gas mixtures for the purpose of efficient resistive $\text{H}_2$ 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 $\text{H}_2$.

References