Hydrogen Detection with a Palladium-Nickel HSGFET

There are now vehicles on our roads run by hydrogen (H)-powered fuel cells, and H$_2$ is predicted to have a far more important role as an energy source in the future. Hydrogen is a highly flammable gas, and being odourless and colourless is not detectable by human olfactory and other senses. Therefore to have sensors able to detect it rapidly and accurately in the atmosphere is very important. This is particularly critical at high H$_2$ concentrations before ignition concentrations are reached.

One method of sensing could be to measure the work function change due to H physisorption or chemisorption on a gas sensitive layer. As the response to bulk effects is almost negligible, the measurements could be carried out at low temperatures, in contrast to the usual conductance sensors which work at very high temperatures. A new type of gas sensor may then be constructed, utilising a hybrid suspended gate field effect transistor (HSGFET), of low power demand (< 10 mW). Pd-MOS based H sensors are already known, but when operated at high H$_2$ concentrations the Pd film blisters. If Pd alloys are used instead of Pd there is a possibility that blistering could be eliminated.


Pd-Ni and Pd-Ag films were grown onto titanium-coated silicon wafers in UHV chambers at a base pressure of 1 × 10$^{-10}$ Torr by co-evaporation techniques. Work function measurements and time responses on exposure to H$_2$ and other commonly found environmental gases were then carried out.

It was found possible to detect H$_2$ concentrations of up to 2% at room temperature without blister formation, when Pd-Ni alloy was used as the gas sensitive material. The response to 2% H$_2$ was ~ 500 mV in dry conditions, but less than half this value with moistened carrier gas, however then the desorption time was lowered. The Pd-Ag alloy was not stable and is not suitable as a sensor material. The Pd-Ni alloy, in addition to having a low cross-sensitivity to other gases, seems to be a promising material for room temperature H monitoring.

Tailored Palladium/Silica Spheres

The ability to control the preparation of porous materials used as supports is important in the fields of heterogeneous catalysis and molecular sieving. Templates of colloidal silica crystals and anion exchange resins as templates have resulted in controlled pore sizes and macrostructures.


Their method is based on the fact that the resin-silica composite, obtained after the ion exchange of silica species, retains a high anion exchange capacity. This allows the introduction of negatively charged ions, such as PdCl$_4$$. Calcination removes the resin bead template and the Pd is converted to an oxide form. Hard, solid silica spheres with a controllable amount of Pd can be prepared by this technique. With their high surface areas and large pore volumes, these materials may be useful for catalytic applications.