62 E. Wicke and H. Brodowsky, "Hydrogen in Metals", eds. G. Alefeld and J. Völkl, Vol. 2, Springer-Verlag, Heidelberg, 1978

63 H. Frieske and E. Wicke, *Ber. Bunsenges Phys. Chem.*, 1973, 77, 48

64 D. Everett and P. Sermon, *Z. Phys. Chem. NF*, 1979, 114, 101

65 T. Mütschele and R. Kirchheim, *Scr. Metall.*, 1987, 21, 135

66 T. Mütschele and R. Kirchheim, *op. cit.* (Ref. 65), p. 101

67 H. Natter, B. Wettmann, B. Heisel and R. Hempelmann, *J. Alloys Compd.*, 1997, 253–254, 84

68 A. Pundt, C. Sachs, M. Winter, M. Reetz, D. Fritsch and R. Kirchheim, *J. Alloys Compd.*, 1999, 293–295, 480

69 J. Eastman, L. Thompson and B. Kestel, *Phys. Rev. B*, 1993, 48, 84

70 A. Züttel, Ch. Nützenadel, G. Schmid, D. Chartouni and L. Schlapbach, *J. Alloys Compd.*, 1999, 293–295, 472

The Authors

Ted B. Flanagan is Professor of Chemistry at the University of Vermont, U.S.A. His main interests are the thermodynamics of metal hydrogen systems and H-induced lattices changes.

R. Balasubramaniam is Associate Professor of Materials and Metallurgical Engineering at the Indian Institute of Technology, Kanpur, India. His interests include the effect of H on materials and archeological metallurgy.

R. Kirchheim is Director of the Institut für Materialphysik, Göttingen, Germany. His main interests encompass the physics of materials in particular the role of H in characterising defective and nanosized metals and alloys.

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.

A team of researchers from Germany, Sweden and India have now attempted to improve the stability of HSGFETs up to high H_2 concentrations, by replacing Pd by a thin layer of Pd-Ni or Pd-Ag alloy (K. Scharnagl, M. Eriksson, A. Karthigeyan, M. Burgmair, M. Zimmer and I. Eisele, *Sens. Actuators B, Chem.*, 2001, 78, (1–3), 138–143).

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 have resulted in controlled pore sizes and macrostructures.

Now, researchers from Sweden report the synthesis of Pd-containing silica spheres prepared by using anion exchange resins as templates (L. Tosheva and J. Sterte, *Chem. Commun.*, 2001, (12), 1112–1113).

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 $PdCl_4^{2-}$. 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.