hydrogen concentrations, indicating that the sample is constrained to operate well within the α-phase, as there is plainly not enough material to allow for a comprehensive lattice expansion. This results from the island nature of the film.

We have also observed that for palladium films with thickness exceeding 30 nm, there appears to be a catastrophic failure in the response; this can be linked to the dimensional changes associated with the transition to the β-phase hydride.

The primary application of this technique – of using the fractional changes in reflectivity of palladium thin films to observe changes in the hydrogen content in the surrounding gas – will be for sensing various gases and monitoring the rate and degree of surface contamination of the thin sensing film. The laser technique can be applied to any gas-metal system.

We conclude by noting that this very simple technique, namely monitoring the FCR of palladium films exposed to various hydrogen gas concentrations at room temperature and pressure, can recover important information regarding the properties of palladium thin films which would be impossible to make via electrical measurements.

References

1 A. Mandelis and C. Christofides, 'Physics, Chemistry and Technology of Solid State Gas Sensor Devices', Vol. 125 in "Chemical Analysis", Wiley Interscience, New York, 1993

2 F. A. Lewis, in "The Palladium/Hydrogen System", Academic Press, New York, 1967

3 G. A. Frazier and R. Glosser, *J. Less-Common Met.*, 1980, **74**, 89

4 M. A. Butler, *J. Electrochem. Soc.*, 1991, **138**, (9), L46

5 K. Kalli, A. Othonos, C. Christofides, A. L. Spetz and I. Lundström, *Rev. Sci. Instrum.*, 1998, **69**, (9), 3331

High Surface Area Porous Platinum Electrodes

Electrodes with high specific surface areas are needed in batteries, fuel cells and sensors for good efficiency and to aid in the production of small size devices. High surface area electrodes can be produced by controlled electrodeposition, by using the pores in lyotropic liquid crystals, by thermal decomposition of a precursor or by sputtering, the latter being suitable for complex objects.

Now, scientists in the U.S.A. have studied highly porous sputtered platinum dioxide, α-PtO_2, films as the precursor to high surface area platinum electrodes (L. Maya, G. M. Brown and T. Thundat, *J. Appl. Electrochem.*, 1999, **29**, (7), 883–888).

PtO_2 films 2–4 μm thick, were prepared by reactive sputtering using oxygen-argon, and then reduced to Pt either by room temperature exposure to a hydrogen-argon mixture or by electrochemical reduction. For comparison, Pt films were also produced by sputtering in pure argon.

The reduced films had density of 3.4 g cm^{-3}, while the argon-sputtered films had density 16.3 g cm^{-3}. The microstructure of the precursor films was porous and remained porous on reduction in hydrogen, which suggests a potential use as high specific area electrodes.

Electrochemical reduction of the oxide-derived film showed Pt, oxide and the gold substrate, which indicates it may be possible to used platinum dioxide as a medium for maskless generation of microscopic metallic Pt features using scanning tunneling microscopy. The system could be used to fabricate Pt quantum dots of nanometre diameters for single electron devices.

MOCVD of Platinum Metals Films

The deposition of thin metallic and oxide films of platinum group metals via metal-organic chemical vapour deposition (MOCVD) is used for electronics, catalytic materials and advanced coatings. However, the films can be contaminated with impurities if precursors such as $Pt(PF_3)_4$ and $(C_3H_7O_2PtMe_3)_2$ are used and the MOCVD process has not removed them.

Now, scientists have synthesised a new precursor: methylcyclopentadienyl-(η^3-allyl)platinum for platinum deposition (G. Rossetto, P. Zanella, G. Carta, R. Bertani, D. Favretto and G. M. Ingo, *Appl. Organomet. Chem.*, 1999, **13**, (7), 509–513). High quality and purity Pt films were deposited, probably due to the methyl-substituted cyclopentadienyl ligands being good leaving groups.

MOCVD has also been used to grow epitaxially conductive ruthenium dioxide thin films on $LaAlO_3$(100) and MgO(100) crystal substrates (P. Lu, S. He, F. X. Li and Q. X. Jia, *Thin Solid Films*, 1999, **340**, (1, 2), 140–144). Bis(cyclopentadienyl)Ru was the precursor and oxygen the reactant gas. The deposited films were crack-free, adhered well to the substrates and had room temperature resistivity of 40–50 μΩ cm.