refining, and in the waste water resulting from its use as the catalyst in the preparation of steroids and as a stain for tissue samples being prepared for electron microscopy. However, no localised loss of osmium sufficiently large to create an obvious environmental hazard was identified. The toxicity of osmium tetroxide is well recognised and could pose a serious health hazard to operators unless handled with adequate caution.

The end result is that the authors have produced a book that will probably disappoint environmentalists but which could be a useful source book for others.

C.W.B.

Reference

1 "Platinum-Group Metals", by Subcommittee on Platinum-Group Metals, Committee on Medical and Biologic Effects of Environmental Pollutants, National Academy of Sciences, Washington, D.C., 1977, p. 175

Hydrogen Diffusion through Palladium Alloys

SOLUBILITY GRADIENTS EXPLAIN PERMEABILITY BEHAVIOUR

Diffusion through palladium–silver membranes is now a well established commercial route for the production of ultra high purity hydrogen. Continuing attempts to find better membrane materials have shown that palladium alloyed with the rare earth elements cerium or yttrium has certain appreciable advantages, although poisoning of the membrane surface can make evaluation of the materials difficult, particularly at low differential pressures, and may also limit permeability.

Recent work carried out at the University of Birmingham using equipment constructed to avoid contamination of the surface has now been reported by D. T. Hughes and I. R. Harris (*J. Less-Common Metals*, 1978, **61**, (2), 2–21). Permeability and solubility measurements were made on palladium-25 atomic per cent silver, palladium-5.75 atomic per cent cerium and palladium-8 atomic per cent yttrium, over a temperature range 20 to 500°C and at differential pressures of 3.4 and 6.8 atmospheres of hydrogen. It is believed that the stringent precautions taken to clean the measuring system have enabled the intrinsic permeability of the materials to be measured.

When the surface processes are unimpeded by poisoning, the rate controlling factor for the permeation of hydrogen through the membrane is the diffusion of hydrogen through the bulk material. The results confirm the greater permeability of the yttrium containing alloy, especially at the higher temperatures, although below 250°C the difference is small. The figures for the cerium alloy show that at the lower differential pressure the permeability is practically the same as for the silver alloy at all temperatures, while at the higher pressure difference the rate is slightly lower in the range 200 to 350°C but slightly greater above 350°C.

Hydrogen solubility measurements were also made under the same experimental conditions, thus enabling the concentration difference between the high and low pressure surfaces of the membrane to be obtained. Diffusion coefficients calculated from these solubility and permeability data showed very similar values for all three alloys. However, it was found that the hydrogen solubility in the yttrium containing alloy is greater than for the other two materials at most conditions of temperature and pressure. The solubility–temperature relationships for this alloy are similar to that of the palladium–silver alloy, but the cerium alloy exhibits some unusual features. In particular, above 250°C, the hydrogen solubilities for the palladium–cerium alloy show a lower temperature dependence than the other two alloys, especially in the measurements made at a hydrogen pressure of 1 atmosphere.

Solubility measurements have shown therefore that the permeability behaviour of the alloys examined is a result of the intrinsic differences in the hydrogen solubility rather than differences in diffusion coefficients. This is supported by the fact that independently determined solubility data can be used with success to analyse the differences in the permeability versus temperature curves. As well as confirming the superior performance of the palladium–yttrium alloy the work has also demonstrated the meticulous care which is required to avoid poisoning of the membrane surfaces during work with these rare earth containing alloys.

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