

from the diffuser and associated equipment. In addition, cooling the membrane in the absence of hydrogen prevents embrittlement of the fragile diffusion tubes.

On a number of occasions, when cylinder hydrogen has been re-introduced to the diffuser after a nitrogen purging process, there has been a serious reduction in the rate of hydrogen output, apparently due to some form of contamination of the membrane. The nitrogen purge was undertaken while the unit was at 310°C using high purity gas, but without an oxygen removal catalyst in the input line. The low hydrogen output could therefore result from the formation of an oxide on the surface of the membrane. One such faulty membrane was removed from its housing and etched for 2 minutes in a hydrofluoric acid solution made from 40 per cent hydrofluoric acid stock diluted by 50. A simple PVC tube, closed at one end, served as a container for the etchant. The palladium-silver membrane tube was then washed for several minutes in a flow of de-ionised water and dried at 100°C for about 15 minutes. The hydrofluoric acid treatment was chosen to promote the formation of silver fluoride, which as the hydrate has a high water solubility. The reassembled diffuser initially gave only a modest improvement in hydrogen flow but on

increasing the temperature from 310 to 360°C the full output of the unit was realised. The operating temperature was then returned to 310°C without any reduction in the pure hydrogen gas output.

Conclusion

The MOVPE process requires a source of oxygen-free carrier gas, this can be readily achieved using a palladium-silver membrane diffusion system. In the event of the external (input) surface of diffuser elements becoming oxidised a simple etch in hydrofluoric acid is able to recover the hydrogen flow. The method relies on the conversion of the oxide to a fluoride, which in the case of the silver fluoride hydrate is known to have a high water solubility.

Acknowledgements

“EP-20” hydrogen diffusion units are supplied by Hydrogen Engineering Applications Ltd., Stevenage, Hertfordshire, and incorporate diffusion membranes manufactured by T.M.K.K., Tokyo, using palladium-silver tubes manufactured by Johnson Matthey.

References

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Tungsten-Iridium Alloys at High Temperatures

The benefit of alloying additions of palladium in improving the oxidation resistance of tungsten alloys at elevated temperatures has been reported in this journal recently (1). Now, the enhancement of the high temperature strength of tungsten by alloying with iridium is the subject of a new study at the Arizona State University (2).

The investigators report that dilute alloys containing up to 1 weight per cent iridium in solid solution display considerably enhanced yield and tensile strengths at high temperatures. For a tungsten-0.8 weight per cent iridium alloy, a yield strength improvement of 75 per cent is observed at 1727°C. This gain becomes progressively less marked as the temperature increases towards 2327°C. The incremental strength benefit was found to be linearly dependent on the iridium concentra-

tion, consistent with the mechanism of solid solution strengthening by atoms in substitutional positions causing symmetrical lattice distortion. Examination of the fracture behaviour showed that iridium promotes the intergranular failure mode at lower temperatures.

These results demonstrate that iridium is a viable alternative to rhenium as a strengthening alloying element in tungsten. Earlier work by the authors has shown that iridium also improves the fabricability of tungsten at ambient temperatures, and is better than rhenium. Such findings should encourage the use of tungsten-iridium alloys in industrial applications.

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