Fig. 5, for example, shows the structure of the vacuum annealed material which, after being reduced in area by 20 per cent and subsequently aged, did not develop a yield point. The metal aged after a 75 per cent reduction in area had recrystallised completely as shown in Fig. 6.

Under high power optical examination, the grain boundaries of material which exhibited a pronounced yield point were indistinguishable from those of normal ductile palladium and no evidence of precipitation on ageing was ever detected with the optical microscope. The structure as revealed by high power transmission electron microscopy is shown in Fig. 7. No constituent that might be responsible for the strong yield point exhibited by the material from which this specimen was taken can be observed in this diffuse cellular structure. Calcium, when added to destroy the yield point, appears to clarify the microstructure to some extent. The globular dispersion shown in Fig. 8 probably represents the residue of the calcium silicide or silicate phase which did not separate from the palladium and adhere to the refractory during melting.

Acknowledgements

The authors would like to acknowledge the expert assistance of Mr J. Day and Miss J. M. Yorke, who made valuable contributions to this work. They are most grateful to Mr A. A. Hershman of the BNFMRA who carried out the transmission electron microscopy.

Reference

1 R. G. Hollister, British Patent Appln. 43404/63

The Palladium-Hydrogen System

The Palladium-Hydrogen System, by F. A. Lewis, Pp. xii and 178. Academic Press, London and New York. 45*s*. ($9.00)

The ability of palladium to dissolve very large volumes of hydrogen without losing its ductile metallic character continues to fascinate many gifted investigators and few problems in physical chemistry have received such detailed attention as this remarkable binary system. Dr Lewis has been active in this field of study for many years and he provides in this book a concise and accurate summary of the present state of knowledge.

Until quite recently the palladium-hydrogen system was of theoretical rather than of practical importance and it was generally believed that a fuller understanding of the constitutional relationships of its non-stoichiometric phases would help to resolve some basic thermodynamic anomalies. The chapter dealing with thermodynamic factors can, in fact, be regarded as a monograph complete in itself.

The chapter dealing with the effect of hydrogen on the shape and properties of palladium is of direct practical importance, and provides what is probably the first complete and systematic survey of this problem. Alloy characteristics are interpreted in metallographic terms and much of the information provided should be of direct value to engineers using semi-permeable membranes of palladium for chemical separation processes and fuel cell development.

Palladium cathodes can be readily charged with hydrogen, and the electrochemical techniques which have been employed for quantitative studies of the hydrogen content and dissociation pressures of palladium-hydrogen solid solutions are comprehensively treated in this book. Industrial considerations are not neglected, however, and considerable attention is given to the rates at which hydrogen diffuses through palladium and its alloys and to the technical problems involved. Pure palladium is unsuitable for use as an industrial diffusion membrane because of the distortion and cracking which occurs when it is cooled in the presence of hydrogen. The characteristics of silver-palladium alloys, some of which are free from this defect, are well described and alternative materials such as platinum, gold and boron palladium alloys are mentioned.

The references provided supplement and bring up to date the bibliography of D. P. Smith, and the book can be confidently recommended to those chemists, engineers and metallurgists involved in the rapidly increasing industrial applications of palladium and its alloys.

A. S. D.