combination of corrosion resistance and high surface area is difficult to achieve, especially in the oxidising environment at the cathode. The main advances have been obtained by graphitising the carbons and various thermal treatments have been used to obtain degrees of ordering of the carbon structure (13, 14).

The major portion of the polarisation of the fuel cell under load occurs at the cathode, the hydrogen oxidation reaction being much more facile. Various alloys have been proposed to improve the activity of the anode, including both platinum/palladium (15) and also platinum/ruthenium. The activity of cathode catlaysts is markedly improved by incorporation of base metal elements to form intermetallic compounds (16, 17). Such work is likely to lead to substantial improvements in the utilisation of platinum group metals in the near future.

To summarise, a huge effort to develop and demonstrate fuel cell systems for gas and electric utilities applications is in progress in both the U.S.A. and Japan. All of these programmes nearing commercialisation use platinum catalysts for the vital power section, most of these being supplied by Johnson Matthey. If tuel cells fulfil the promising forecasts for implementation over the next twenty years, the supply of platinum should prove adequate to meet the requirements. In the meanwhile, Johnson Matthey is continuing to further the technology by contributing noble metal expertise to collaborative efforts being made with a number of fuel cell developers.

References

1 S. Carnot, "Reflexions sur la Puissance Motrice du Feu", (monograph), 1824

2 W. R. Grove, *Phil. Mag.*, 1839, **14**, 127; *ibid.*, 1842, **21**, 417

3 L. Mond and C. Langer, *Proc. Roy. Soc.*, 1889, **46**, 296

4 P. N. Ross, National Fuel Cell Seminar, Orlando, Florida, 13–16 Nov. 1983

5 E. Raia, *High Technol.*, 1984, **4**, (12), 52

6 S. Srinivasan in "Advances in Hydrogen Energy", ed. T. N. Veziroglu, Hydrogen Energy Progress 5, 1984, **14**, 1717

7 "Description of a Generic 11 MW Fuel Cell Powerplant for Utility Applications", Electric Power Research Institute, Report No. EPRI EM 3161, Palo Alto, California, Sept. 1983

8 B. E. Curry, "The Fuel Cell—Electric Utility Planning Perspectives", 36th Annu. Symp. New Engl. Conf. Public Util. Comm., Farmington, Connecticut, 14 June 1983, Electric Power Research Institute, Palo Alto, California, 1983

9 E. R. Gonzalez and S. Srinivasan, Proc. 4th World Hydrogen Energy Conf., 13–17 June 1982, in Hydrogen Energy Progress IV

10 B. D. McNicol, *J. Electroanal. Chem. Interfacial Electrochem.*, 1981, **118**, 71

11 H. Van den Broeck and D. S. Cameron, *Platinum Metals Rev.*, 1984, **28**, (2), 46

12 A. T. Emery, National Fuel Cell Seminar, Orlando, Florida, 13–16 Nov. 1983

13 P. Stonehart, *Carbon*, 1984, **22**, (4/5), 423

14 Proc. Workshop on the Electrochemistry of Carbon, Case Western Reserve Univ., 17–19 Aug. 1983, ed. S. Saragapani, J. R. Akridge and B. Schumm, Proc. Electrochemical Soc. Inc., **84–5**, New Jersey, U.S.A.

15 P. Stonehart, *Adv. Hydrogen Energy*, 1982, **3**, (Prog. 4), 1149

16 D. A. Landsman, *U.S. Patent* 4,373,014; 1983, V. M. Jalan, *U.S. Patent* 4,202,934, 1980

17 D. A. Landsman and F. J. Luczak, *U.S. Patent* 4,316,944; 1982, V. M. Jalan and D. A. Landsman, *U.S. Patent* 4,186,110; 1980

Osmium-Platinum Alloys

HIGH STRENGTH PROPERTIES AT HIGH TEMPERATURES

Searching for new platinum alloys for use in industry under stress and at high temperatures metallurgists at the Academy of Sciences of the U.S.S.R. in Moscow have carried out a full investigation of the osmium-platinum system (L.I. Voronova, V.P. Polyakova and E.M. Savitskii, *Metally*, 1984, (5), 191-193). The phase diagram is a simple peritectic type with no intermediate phase, the maximum solubility of osmium being around 25 atomic per cent.

Alloys with 10 atomic per cent osmium were ductile at room temperature and both wires and foils were successfully prepared, but the most remarkable finding was the very considerable increase in hardness at high temperatures in alloys with up to 27 atomic per cent osmium, even up to 1600°C, the authors stating that this property was increased by from 20 to 40 times. Creep rates at 1200 and 1400°C were also found to be appreciably lower.