

References

- 1 Y. Sakamoto, K. Kajihara, T. Kikumura and T. B. Flanagan, *J. Chem. Soc., Faraday Trans.*, 1990, **86**, 377
- 2 F. L. Chen, M. Furukawa and Y. Sakamoto, *J. Less-Common Met.*, 1989, **155**, (2), 173
- 3 Y. Sakamoto, K. Baba and T. B. Flanagan, *Z. Phys. Chem. Neue Folge*, 1988, **158**, 223
- 4 Y. Sakamoto, K. Yuwaa and K. Hirayama, *J. Less-Common Met.*, 1982, **88**, 115
- 5 M. L. H. Wise, J. P. G. Farr and I. R. Harris, *J. Less-Common Met.*, 1975, **41**, 115
- 6 S. Ramaprabhu, N. Rajalakshmi and A. Weiss, *Ber. Bunsenges. Phys. Chem.*, 1989, **93**, 686
- 7 S. Ramaprabhu, R. Leiberich and A. Weiss, *Z. Phys. Chem. Neue Folge*, 1989, **161**, 83
- 8 E. Wicke and K. Frölich, *Z. Phys. Chem. Neue Folge*, 1989, **163**, 35
- 9 K. Kandasamy, F. A. Lewis, W. D. McFall and R.-A. McNicholl, *Z. Phys. Chem. Neue Folge*, 1989, **163**, 41
- 10 F. A. Lewis, K. Kandasamy and B. Baranowski, *Platinum Metals Rev.*, 1988, **32**, (1), 22
- 11 B. Baranowski, S. Majchrzak and T. B. Flanagan, *J. Phys. F, Metal Phys.*, 1971, **1**, 258
- 12 R.-A. McNicholl and F. A. Lewis, results to be published

Platinum-Enhanced Corrosion Resistance in Amorphous Metals

The attainment of amorphous ("glassy") structures in certain metallic alloys has aroused considerable industrial interest because of the pronounced enhancement of properties such as corrosion resistance, ductility, and magnetic properties that can be achieved, compared to alloys in their normal crystalline state.

The enhancement of the corrosion resistance of conventional crystalline base metal alloys by small additions of the platinum group metals is well documented; the addition of 0.1 per cent palladium to titanium is, perhaps, the best known example and is widely used in chemical engineering applications. None the less it is, perhaps, surprising to find that small additions of platinum can significantly enhance the corrosion resistance of amorphous alloys.

The results of studies made on amorphous chromium alloys have recently been reported by M. Tenhover, G. A. Shreve, R. S. Henderson and D. B. Lukco of the BP Research Center, Ohio, U.S.A., (*Appl. Phys. Lett.*, 1989, **55**, (17), 1724-1726). They prepared amorphous alloys of Cr-*M* and Cr-Pt-*M*, where *M* is phosphorus, boron, carbon or nitrogen, as sputtered thin films 0.5 to 1.0 μm thick on glass slides. Corrosion testing was conducted in hydrochloric acid over a temperature range of 25 to 250°C, in 50 weight per cent hydrofluoric acid at room temperature, in refluxing concentrated nitric acid at 121°C and in refluxing sulphuric acid at 100°C.

Amorphous Cr₈₅P₁₅ was observed to be stable in hydrofluoric, nitric and sulphuric acid solutions, whereas crystalline chromium dissolved rapidly in the reducing acids, hydrochloric and sulphuric. Both materials, however, corroded rapidly in hot concentrated hydrochloric acid, whereas amorphous

chromium-platinum-phosphorus alloys were very stable in all four test solutions. More particularly, Cr_{74.9}Pt_{0.1}C₂₅ in the amorphous form was also stable in all four test solutions. In the crystalline state, however, it was only stable in hydrofluoric acid.

More detailed work on the effect of platinum concentration in amorphous Cr_(85-b)Pt_bP₁₅ alloys shows that there is a trade off between corrosion rates in oxidising and in reducing acids. In nitric acid, the corrosion rate increased substantially when the platinum content exceeded a critical value, while in the hydrochloric acid the corrosion rate decreased dramatically to a low rate at a similar amount of platinum addition. Thus there is an optimum platinum content of about $b=0.1$, that is Cr_{84.9}Pt_{0.1}P₁₅. High temperature tests in hydrochloric acid showed that the platinum-containing alloys had higher temperature stability in terms of the transition from passive to active behaviour.

Analysis of the surfaces of corroded specimens revealed an enrichment of platinum concentration in the top 20 to 30 Å of the surface, which was present in the metallic unoxidised state. Cathodic polarisation measurements showed the platinum-containing alloys to have a hydrogen exchange current three orders of magnitude higher. The authors conclude that the platinum additions accelerate the passivation reaction, changing both anodic and cathodic reaction kinetics.

In summary, the authors state that the use of trace additions of platinum to amorphous chromium alloys produced alloys that are among the most corrosion resistant known, thus offering a new freedom in the design of corrosion resistant materials. C.W.C.