51 G. Shinoda, *Proc. Phys.-Math. Soc. Jpn.*, 1934, **16**, 436
52 H. Esser, W. Eilander and K. Bungardt, *Arch. Eisenhüttenw.*, 1938, **12**, 157
53 A. Eisenstein, *J. Appl. Phys.*, 1946, **17**, 434
54 J. W. Edwards, R. Speiser and H. L. Johnston, *J. Appl. Phys.*, 1951, **22**, 424
55 F. A. Mauer and L. H. Bolz, U.S. Air Force Rept. WADC-TR-55-473, 1955 and Suppl. No.1 Nat. Bur. Stand. Rept. NBS-5837, 1957
56 J. A. Brand and H. J. Goldschmidt, *J. Sci. Instrum.*, 1956, **33**, 41
57 L. G. Lui, T. Takahashi and W. A. Bassett, *J. Phys. Chem. Solids*, 1970, **31**, 1345
58 S. Valentiner and J. Wallot, *Ann. Phys. (Leipzig)*, 1915, **46**, 837
59 Yu. A. Kraftmakher, *Fiz. Tverd. Tela*, 1967, **9**, 1528; [*Sov. Phys.- Solid State*, 1967, **9**, 1197]
60 K. Andres, *Phys. Kondens. Mater.*, 1964, **2**, 294
61 M. Seigbahn and A. Leide, *Philos. Mag.*, 1919, **38**, 647
62 M. Seigbahn, *Ark. Mat. Astron. Fys.*, 1920, **14**, (9)
63 W. L. Bragg, *J. Sci. Instrum.*, 1947, **24**, 27
64 T. N. Mel'nikova, M. S. Trakhtengerts and K. A. Yakimovich, *High Temp.-High Pressures*, 1987, **19**, 407
65 T. N. Mel'nikova and A. G. Mozgovoi, *Teplofiz. Vys. Temp.*, 1988, **26**, 1099; [*High Temp.*, 1988, **26**, 848]
66 T. N. Mel'nikova, *Teplofiz. Vys. Temp.*, 1989, **27**, 185
67 T. N. Mel'nikova and A. G. Mozgovoi, *Teplofiz. Vys. Temp.*, 1989, **27**, 490; [*High Temp.*, 1989, **27**, 382]
68 J. W. Arblaster, in preparation

Shiny Adhesive Platinum Coatings

The deposition of platinum coatings from electroplating baths onto various substrates has been written about here on previous occasions (1, 2). The use of Q-salts has been particularly successful, and finds commercial application for plating the turbine blades of jet engines, so extending the life of the blades and the time between replacements.

Now, researchers at Southampton University, England, have used platinum electroplating baths at the typical deposition temperature of 368 K, and at various potentials to examine the morphology of coatings produced on polished copper substrates (3).

They found that the morphology of the deposits depended strongly on the deposition potential. At a potential of –650 mV the deposit shows the cauliflower-like structure, typical of many high performance electroplates, and consists of many overlapping hemispheres, 0.5 to 2 μm in diameter. This coating is highly stressed, adhesion is poor and cracks are apparent; these increase as plating thickness increases.

As the potential is shifted to more negative values, such as –700 and –750 mV, which are potentials close to the peak in the current/potential response, the deposits appear shiny and highly reflective. Micrographs show very little structure, the deposits consisting of very small, tightly packed, crystallites. At the more negative potential the coatings display the strongest adhesion to the substrate and the crack density decreases. These deposits may be made at 13 mA cm^{-2}, with high current efficiency. At even more negative potentials, the morphology totally changes, structure then consists of angular grains of dimension ~ 0.5 μm; the appearance is metallic, but semi-bright, and all signs of stress have disappeared. There are no cracks and adhesion is very good. With significant hydrogen evolution the current efficiency drops and the deposit becomes increasingly matt in appearance.

Thinner platinum layers, 0.5 to 1.2 μm thick, were also deposited. For thin deposits at potentials positive to –800 mV the deposits are highly reflecting with good adhesion to the substrate and no evidence of cracking, although any surface blemishes on the underlying copper were visible.

At a current density of 13 mA cm^{-2} and a constant potential of –750 mV, the deposition rate can reach 12.9 μg cm^{-2} s^{-1} with high deposit quality, which is more than five times the maximum rate achieved with constant current control. At constant current control, the most similar deposition occurs at a current density of 2.5 mA cm^{-2}, corresponding to a plating rate of 2.4 μg cm^{-2} s^{-1}. The authors conclude that while it may be technically difficult to achieve constant potential deposition, nevertheless it does seem to have considerable advantages over the more usual constant current deposition, and stress- and crack-free coatings, thicker than 5 μm, can be produced. It is thus suggested that deposition at constant potential may provide a cheaper alternative for substrates which have a simple geometry.

References

1 P. E. Skinner, *Platinum Metals Rev.*, 1989, **33**, (3), 102–105
2 W. Levason and D. Pletcher, *Platinum Metals Rev.*, 1993, **37**, (1), 17–23
3 W. J. Basirun, D. Pletcher and A. Saraby-Reintjes, *J. Appl. Electrochem.*, 1996, **26**, (8), 873–880