Goddard Space Flight Center of the 0.91 m diameter telescope mirror of a spectrophotometer flown by astronomers from the Johns Hopkins University on a NASA sounding rocket (3).

Because of their high melting points, the platinum group metals cannot be evaporated by conventional resistance heating techniques used for the vacuum deposition of thin films, since they will alloy with the tungsten heater used for this purpose and cause heater failure. Instead, an electron bombardment technique has been successfully used to prepare pure films (3,4). The evaporation source used, as well as a number of other types commonly used for the deposition of thin films, produces a vapour distribution which varies as the cosine of the emission angle (5). Consequently, when the element to be coated is large compared with the vapour source, as it was in the aforementioned application, realisation of a uniform film thickness can be difficult. Fortunately, once the film thickness of iridium exceeds 10 nm, its reflectance becomes insensitive to further increases (4). Using this information, a reflectance distribution with a coefficient of variation below 1.5 per cent was attained, despite a twofold variation in film thickness over the surface of the mirror.

While an increase in vacuum-ultraviolet reflectance from about 10 per cent for an overcoated aluminium mirror to 20 per cent or more for iridium or other metals in the platinum group may seem quite modest, it represents a significant improvement to scientists studying weak signals from distant sources with instruments using multiple reflections in the optical train.

References

1 G. F. Jacobus, R. P. Madden and L. R. Canfield, *J. Opt. Soc. Am.*, 1963, **53**, 1084

2 G. Hass and W. R. Hunter, in "Space Optics", Proc. Ninth Int. Congr. of the Int. Commission for Optics, Santa Monica, California, Oct., 1972, ed. B. J. Thompson and R. R. Shannon, Natl. Acad. Sci., Washington, D.C., 1974, pp. 525–553

3 H. Herzig and R. S. Spencer, *Appl. Opt.*, 1982, **21**, (1), 15

4 G. Hass, G. F. Jacobus and W. R. Hunter, *J. Opt. Soc. Am.*, 1967, **57**, (6), 758

5 L. Holland, "Vacuum Deposition of Thin Films", Wiley, New York, 1960, p. 141

Carbide Phase Identified in Platinum

While platinum is known to have considerable solubility for carbon in the molten state, metallographic and X-ray diffraction studies reported previously by G. L. Selman, P. J. Ellison and A. S. Darling have shown that in the solid state carbon solubility is very small, the excess carbon precipitating as graphite in flake form (*Platinum Metals Rev.*, 1970, **14**, (1), 14–20). No evidence for the formation of carbide phases was found in this work, nor has it ever been reported in the literature and it is assumed that platinum does not form carbides.

However, recent transmission electron microscopy studies reported from the University of California by M. J. Whitcomb, U. Dahmen and K. H. Westmacott on platinum containing small amounts of carbon retained in supersaturation by quenching has provided direct evidence for the formation of a carbide phase on subsequent ageing (*Acta Met.*, 1983, **31**, (5), 743–747). In their studies on material aged in the temperature range 400 to 530°C, very small plate-shaped precipitates were observed to form on {001} crystallographic planes of the platinum matrix. Electron diffraction measurements reveal the precipitates to have a body-centred-tetragonal structure with a c/a ratio of 3/2 and with a composition equating to Pt_2C.

The discovery of the formation of a platinum carbide phase is, perhaps, surprising although an orthorhombic carbide has been reported in nickel, which is in the same group in the periodic table as platinum and which had also been thought to form only graphite structures with carbon. The stability of the platinum carbide phase is attributed to the formation of stable octets of valency electrons. The 50 per cent volume difference between Pt_2C and the platinum matrix suggests that Pt_2C will be more difficult to nucleate than similar metastable eta carbides in ferrous alloys, which also precipitate as platelets on {001} matrix planes and which are transition phases in a sequence ending in graphite formation. The authors believe that Pt_2C is also an intermediate phase that provides a more energetically-favourable path to graphite formation. C.W.C.