Carbon and the Platinum Metals at High Temperatures

SOME RECENT METALLOGRAPHIC INVESTIGATIONS

The melting point of the carbon platinum eutectic was determined at the National Physical Laboratory in 1934 (1) with exemplary precision although this work was not followed up by further constitutional studies. Nadler and Kempter (2) confirmed in 1960 that carbon depressed the melting points of all the platinum group metals, but no attempt was made to determine the composition of these eutectics or whether the metals were capable of taking any carbon into solid solution. Raub and Falkenburg (3) at the Forschungsinstitut für Edelmetalle, Schwäbisch Gmünd, have recently done much to remedy these deficiencies.

In this work platinum, palladium, rhodium and ruthenium were melted with graphite, heated for long periods in the solid powdered state in contact with graphite, and subjected to prolonged exposure at high temperatures to hydrocarbon vapours. All four metals dissolved large quantities of carbon when melted in graphite crucibles. Platinum, rhodium and ruthenium, on solidification, threw out this carbon in the form of graphite flakes. Palladium precipitated spheroidal graphite particles. The graphite flakes in platinum could be converted to the spheroidal form by remelting the metal in an argon arc furnace.

X-ray diffraction studies showed that these eutectiferous structures were mechanical mixtures of the metals and graphite. The lattice parameter data indicated that the solid solubility of carbon in platinum, palladium, rhodium and ruthenium was vanishingly small, and prolonged heat treatment at temperatures just below the eutectic points failed to induce any of these metals to take up any carbon.

Platinum and palladium will, at high temperatures, decompose tungsten, tantalum and niobium carbides (4). This reaction occurs in either the solid or liquid states. On solidification, graphite is thrown out of solution in the form of spheres or flakes, while the refractory base metal is held in solid solution.

A summary of the melting point determinations of Nadler and Kempter (2) is presented here. Although this table does not show the composition of the eutectics, it illustrates very directly that the melting point depression caused by carbon decreases periodically with increasing atomic weight.

Metal	Melting point t_m in °C	Solidus temperature of metal/carbon alloy t_s in °C	t_s/t_m (°K)
Ruthenium	2310	1942±16	0.859
Rhodium	1960	1694±17	0.881
Palladium	1552	1504±16	0.974
Osmium	3050	2732±22	0.901
Iridium	2443	2296±16	0.946
Platinum	1769	1736±13	0.984

These determinations were done by the 'bracketing' method with an optical pyrometer. The NPL value for the platinum carbon eutectic, corrected to conform with the 1948 International Temperature Scale, is 1730° ± 3°C.

A. S. D.

References

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3 E. Raub and G. Falkenburg, *Z. Metallkunde*, 1964, **55**, 186

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