

Binary Platinum Metal Alloys

A BROAD SURVEY OF STRUCTURAL FEATURES

A most interesting attempt to provide a broad survey of the whole field of platinum metal binary alloys and to get some glimpse of underlying common patterns was presented in a review by Professor Ernst Raub entitled "Metals and Alloys of the Platinum Group", read at a Symposium on the Study of Metals and Alloys above 1200°C held at Oxford and now published in the first issue of a new periodical, *Journal of the Less Common Metals*.

Professor Raub has for very many years been in charge of the Forschungsinstitut für Edelmetalle und Metallchemie at Schwäbisch Gmünd. Here he has been engaged in a long series of systematic investigations of the constitutional characteristics of alloys of the platinum metals with one another and with other metals, in particular with those of high melting point.

Professor Raub has found it possible to distinguish six groups of binary platinum metal alloys:

- (1) Alloys of the f.c.c. platinum metals with one another
- (2) Alloys of the platinum metals with one close packed hexagonal component
- (3) Alloys of the f.c.c. platinum metals with the f.c.c. modifications of iron, cobalt and nickel
- (4) Alloys of the platinum metals with manganese
- (5) Alloys of the platinum metals with metals of Group VIA
- (6) Alloys of the platinum metals with metals of Groups VA and IVA

From all this work certain general principles can be seen to be emerging. The four face-centred cubic platinum metals—platinum, palladium, rhodium and iridium—undoubtedly form, as has long been believed,

binary alloys having an unbroken series of solid solutions at high temperatures. It has now been well established, however, that at lower temperatures in several alloys the platinum metals will no longer take each other into solid solution. Very wide immiscibility gaps have definitely been found in the palladium-iridium system (below about 1500°C), the platinum-iridium (below about 980°C) and the palladium-rhodium (below about 850°C) systems. In all these alloys, the exact limits of the miscibility gap are still uncertain, since even at temperatures around 600°C structural changes in these alloys are extremely sluggish and annealing periods of as long as one year are insufficient to allow true equilibrium to be reached. This sluggishness is especially found in the platinum-iridium system. Professor Raub remarks that it seems certain that miscibility gaps also exist in the platinum-rhodium, platinum-palladium and rhodium-iridium alloy systems at lower temperatures, even though they have not yet been observed. He presents an interesting discussion of the factors that give rise to miscibility gaps and considers that their occurrence is related to the difference between the melting points of the face-centred cubic platinum metals concerned.

Alloys between face-centred cubic platinum metals and one of the close packed hexagonal platinum metals—ruthenium and osmium—have been only incompletely studied, and exact measurements of the limits of solid solubility are again very difficult to make owing to the sluggishness shown by the alloys in reaching equilibrium.

At high temperatures the alloys of the face-centred cubic platinum metals with face-centred cubic modifications of iron, cobalt and nickel call for no special comments

since, as far as is known at present, they all form unbroken solid solutions. At lower temperatures, ordered structures of the CuAu and Cu₃Au type occur in many of these alloys and some of these give rise to interesting magnetic properties, in particular in the platinum-cobalt series. Considerable interest has, in fact, been shown recently in this system since some of the alloys can develop higher values of coercive force and can produce more powerful magnets than any other known permanent magnet material.

The alloys of the platinum metals with manganese are, as may be expected in view of the many modifications of manganese, extremely complex. The face-centred cubic gamma phase of manganese is retained down to room temperature by addition of the platinum metals, except in palladium-manganese alloys where the gamma manganese solid solution decomposes eutectoidally. The platinum-manganese alloys have an ordered structure which is ferromagnetic and it is possible that further studies of the alloys of manganese with the platinum metals might

yield materials with interesting magnetic properties.

When it comes to alloys of platinum metals with Group VIA metals conditions become very complicated. Sigma phases are found in all alloys of the close packed hexagonal platinum metals with these metals and in some of the alloys ferromagnetism is observed. Particular attention has been given to the magnetic properties of the chromium-iridium and chromium-rhodium alloys.

Finally, the alloys of the platinum metals with metals of Groups VA and IVA can be shown to exhibit several systematic relationships. The principal intermediate phases formed can show the structures of caesium chloride, sigma, Laves and β -W phases. It is considered remarkable, however, that sigma phases of alloys in this group are comparatively rare and in particular that only two cases of sigma structure, osmium-tantalum and osmium-niobium, have been found in the alloys of the close packed hexagonal metals with metals of the VA Group.

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TEMPERATURE CONTROL IN THE ZINC BLAST FURNACE

A major development in British extraction metallurgy—a process for smelting lead-zinc concentrates in a blast furnace to yield both zinc and lead as metals directly—has been brought to commercial success by the Imperial Smelting Corporation Ltd. Two furnaces are now in operation at Avonmouth, producing between them 70 tons of zinc per day and varying quantities of lead, depending on the nature of the charge.

Instrumentation and automatic control are features of the process, and a battery of platinum : rhodium-platinum thermocouples is installed for the measurement of temperatures in the higher ranges.

