results of alloying molybdenum with the 3rd Long Period elements from hafnium to platinum. Solution softening is produced only by those elements having an excess of (s+d) electrons compared to molybdenum (i.e. rhenium, osmium, iridium and platinum) while elements with a fewer or an equal number do not produce softening. A particularly good correlation was obtained by plotting hardness as a function of the square of the excess (s+d) electrons; for example, iridium with three electrons in excess was found to be nine times more effective than rhenium with one, but the basis for this correlation remains obscure. Other factors such as atomic size or scavenging of interstitials make only a minor contribution to the hardness behaviour in these alloys.

It is perhaps significant that parallel ductility enhancement has been found in the hexagonal close-packed metal ruthenium when molybdenum is added to near the solid solubility limit. However, there has been no report as yet that osmium, the most intractable of the platinum group metals, responds similarly to alloying.

Effect of Palladium on the High Temperature Properties of Rhodium-Platinum Alloys

The only conventional metallic constructional materials currently available with sufficient strength, ductility, and resistance to oxidation to satisfy the most extreme demands of the glass industry are those based on the binary rhodium-platinum solid solutions. Between the temperature levels at which the use of these relatively costly materials becomes mandatory, however, and the lower temperature region in which nickel- and cobalt-based alloys can safely operate, a sizeable gap can now be distinguished. For many years Dr Gerhard Reinacher of Degussa has searched for cheaper alloys capable of working continuously in this intermediate temperature range. Although no materials having mechanical properties superior to those of rhodium-platinum have emerged from this survey, the possibility of certain economies can now be discerned. The object of his recent work has been to establish the extent to which cheaper and lighter palladium can be substituted for platinum without too catastrophic an effect upon high temperature properties.

In 1971 (1) and again in 1973 (2) he reported on the properties of several ternary alloys, one of which, containing 50 per cent of platinum, 40 per cent of palladium and 10 per cent of rhodium, had high temperature properties rather lower than those of the 10 per cent rhodium-platinum alloy at 1200°C, but high enough to suggest that possible applications might be found for it in the glass industry.

Since 1973 the price of platinum has increased, and significant reductions in cost are possible with even lower palladium concentrations than those Dr Reinacher originally envisaged. He has now shown (3) that at very low stress levels, of the order of 0.5 kgf/mm^2, the 30 per cent palladium, 60 per cent platinum and 10 per cent rhodium alloy performs almost as well in the short term as the conventional 10 per cent rhodium-platinum solid solution. At higher stresses, however, the superiority of the palladium-free alloy becomes increasingly apparent. Thus, under an applied tensile stress of 1 kgf/mm^2 the 30 per cent palladium alloy endures for only 25 hours at 1200°C compared to the 80 to 100 hours life of rhodium-platinum.

On a volume basis the intrinsic cost of this new alloy is approximately 25 per cent lower than that of the 10 per cent rhodium-platinum alloy which is capable of general employment at all temperatures up to 1400°C, whereas an upper temperature limit of 1200°C is imposed upon the palladium-containing material. On the other hand much of the intrinsic metal savings will be offset by the inevitably increased costs of fabrication and welding.

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References

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