rhodium based alloys were obtained from alloys containing mixtures of either refractory group metals, or rare earths and refractory group metal, or refractory group metal with the addition of osmium or iridium.

References

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A Review of Cathodically Modified Alloys

The beneficial effects conferred on base metals and their alloys by small additions of the platinum group metals have been reported here frequently. In recent issues, for example, the literature on the enhancement of corrosion resistance in stainless steels has been reviewed (1, 2); and that on amorphous chromium alloys (3) and surface-implanted titanium alloys has also been reported (4).

The platinum group metals enhance the corrosion resistance of such alloys in corrosive media by modifying the cathodic reaction, and this has led to the description "cathodically modified alloys".

Now, an extensive review of the literature on base metals cathodically modified with noble metals has been published (5). This report surveys the literature on chromium, stainless steels and titanium. The author claims that it is the first comprehensive review of the subject which, he considers, has been neglected as a topic in recent years—the only active groups being Professor Tomashov's team in the U.S.S.R. Academy of Sciences, Moscow and Dr. Higginson and his co-workers at Mintek.

Several studies have been made on the effect of small additions of platinum group metals to chromium in both oxidising and reducing acids. In reducing conditions, platinum group metal modified alloys self passivate easily and their corrosion resistance is several orders of magnitude higher than that of pure chromium. The effectiveness of the platinum group metals is as follows: platinum>palladium>iridium >ruthenium>osmium. During the period of active dissolution that precedes the onset of passivation, an enrichment of the platinum group metals occurs at the alloy surface.

The work carried out on stainless steels in reducing acids shows that platinum group metal additions are more beneficial to ferritic steels than to austenitic steels, and that their effect is enhanced with increasing chromium content of the steel. When molybdenum is also present, there is a synergistic effect with the platinum group metal addition.

More economic use of the platinum group metals through surface alloying, rather than by bulk alloying, favourably influences the commercial viability of cathodically alloyed steels.

In contrast, the alloying of titanium with platinum group metals has been shown to be beneficial in both oxidising and reducing media. Palladium has been the most studied addition, and the research has led to the development of the widely used commercial titanium-0.2 per cent palladium alloy which is particularly suited to service in reducing conditions. Surface alloying by, for example, ion-implantation with palladium or platinum is also effective in conferring enhanced corrosion resistance as well as certain mechanical properties, such as fatigue. C.W.C.

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Oxidation-Resistant Alloys

Tungsten and molybdenum possess high melting points and good mechanical strengths at elevated temperatures, but even at moderate temperatures both oxidise rapidly. Previous studies have shown that tungsten-chromium-palladium alloys have remarkable oxidation resistance when heated in air, and different mechanisms have been proposed to explain the advantageous action of the palladium.

A recent investigation of the oxidation mechanism and of the characteristics of this alloy system, and of some quaternary alloys produced by substituting large amounts of molybdenum for some of the tungsten, has now been reported (D.-B. Lee and G. Simkovich, *J. Less-Common Met.*, 1990, **163**, (1), 51–62).

Between 1000 and 1250°C, the oxidation resistance of the alloys increases with temperature, the molybdenum-containing alloys being the more resistant. The palladium enhances the formation of a protective chromic oxide scale, acts as a reservoir for chromium, facilitates the outward movement of chromium and prevents oxygen diffusing inwards.