Reduced surface roughness

Reduced reaction with investment

Brighter surface in the as-cast state

Reduced surface roughness

The surface of investment cast items comes out much smoother if the alloy contains 1 to 2% Zn. The effect is more pronounced with heavy parts. A reduction of roughness to approximately one third can be achieved.

The reason for this is that both increased form-filling and reduced roughness can be related to the effect of zinc on the interfacial tension. Measurements of interfacial tension showed that reduction to approximately one tenth of the value of a zinc-free alloy might be possible. (However, it has to be said that the results were not very reliable, probably due to variations in casting atmosphere). A reduced interfacial tension improves the wetting of the investment with the melt, and capillary forces are reduced. The melt can fill thin cavities more easily and reproduce the smooth surface of the pattern (avoiding a dendritic structure on the surface).

Brighter surface in the as cast state

Zinc has a stronger affinity to oxygen than gold, silver and copper. During the cooling period of a casting, a thin and relatively dense layer of colourless zinc oxide is formed on the surface of the cast item. It replaces the thick black, porous layer of copper oxide, normally seen on zinc-free carat golds. The castings have a bright yellow appearance. Pickling removes the zinc oxide layer easily without any discolouration of the surface.

Reduced reaction with investment

Small zinc additions have been proven to reduce the reaction with the investment and, in this way, reduce also gas porosity. The reason for this is not quite clear but, probably, the formation of a dense layer of zinc oxide at the surface of the solidifying melt prevents the interaction of the melt with the investment.

Side effects

Zinc is an addition with relatively few detrimental side effects, especially if the concentration is kept low. The main disadvantages are:

A) The formation of stable zinc oxide

a) with increasing zinc concentration,

b) when melting and casting under oxidising conditions,

c) when using polluted material as the charge for melting.
Factors are probably the main reasons for the defects.

B) The high vapour pressure of zinc

Pure zinc boils at 907°C, that is, the vapour pressure reaches atmospheric pressure. Added as a small addition in gold alloys, the partial vapour pressure of zinc is significantly reduced. To a very rough approximation, the vapour pressure of zinc is reduced to 1/20 the value of pure zinc in an 18 ct alloy with 2% Zn, and to 1/10 the value in a similar alloy with 5% Zn. On the other hand, the vapour pressure increases strongly (exponentially) with temperature. An increase in temperature of 200 K (°C) more than the boiling point of pure zinc increases the vapour pressure by factor of 5.

C) Increased reaction with the investment

This happens if too high a concentration of zinc is used. If the optimum zinc addition is exceeded, the reaction with the investment increases again, leading to gas porosity and surface defects.

Recommendation for application

In general, additions of zinc to jewellery alloys based on gold silver- copper can be recommended. The restrictions mentioned above, especially concerning the concentration range, should be taken into account. Melting of zinc-containing alloys may result in zinc loss by evaporation of zinc. The extent depends on concentration and temperature. The danger of loss is lowered with low zinc concentration, use of a reduced pressure atmosphere (instead a high vacuum) and a reduced melt superheat.

Ref. : Ganoskin

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