The Wettability of Glass on Metals

SOME NEW DATA ON PLATINUM AND PLATINUM ALLOYS

The handling characteristics of molten glasses when processed in platinum equipment are influenced to a considerable degree by the extent to which the containment metal or alloy is wetted by glass at the processing temperature. Pure platinum is wetted fairly readily by molten glass, and while in many instances this behaviour has to be tolerated in the interests of maintaining glass purity, and to be overcome by equipment design, some opportunities do exist in less critical applications for an improved constructional material, more resistant to wetting.

A recent study conducted at the Chinese Institute of Precious Metals, in collaboration with the Nanjing Institute of Glassfibre, has provided some interesting data on the wetting characteristics of a number of binary and ternary platinum based alloys which have allowed some qualitative correlations to be made between the glass-metal contact angle and the affinity of the alloying constituents for oxygen. (N. Yuantao, W. Yongli and Y. Qilong, *Fenzi Kexue Xuebao*, 1982, **2**, (1), 33–42).

In the experimental work, the equilibrium contact angles of "E" and "G" glass were measured over a range of temperatures on polished plaques of platinum alloys containing binary additions of copper, silver, tin, iridium, osmium and ruthenium. Ternary alloys containing rhodium + zirconium and rhodium + gold were also investigated.

The equilibrium contact angle of "E" glass on the binary alloys examined was shown, as expected, to be highly temperature-dependant at temperatures below 1200°C. Above this point the contact angle changed only marginally with increasing temperature on a majority of the alloys investigated. Using 1200°C as the reference point, it was clear that 1 weight per cent additions of ruthenium, osmium and iridium increased the resistance of platinum to wetting; copper, silver and tin on the other hand caused a significant increase in wettability when present at this concentration in the alloy. As anticipated, gold considerably increased the wetting resistance of platinum-rhodium alloys, whereas zirconium had the opposite effect.

The relative behaviour of the two glass compositions was examined with respect to the ternary gold bearing alloys. Over the range of gold contents evaluated the equilibrium contact angles were significantly greater when the alkali-free "E" glass was employed.

The authors move on to consider the results of these experiments against a theoretical model of the wetting process. They argue that the chemical bond at the interface, which effectively determines the interfacial energy, and hence the contact angle, may be considered to be of the form M-O-Si-O-I, where M is the wetted metal and I the cation in the molten glass. When the bonding energy M-O is high, that is when the affinity of the metal for oxygen is large compared to the affinity of the glass cation for oxygen, a low contact angle should result, and vice versa. Based on electronic structure considerations the authors define a "chemical bond parameter" for pure metals which describes the relative affinities of the metals for oxygen, and indicate that a strong relationship exists between this parameter and the equilibrium contact angle achieved on platinum alloys containing 1 atomic per cent additions of second metals. A similar bond parameter is developed for the glass cations to explain their effect on wetting behaviour as the glass composition is changed.

With the exception of the gold bearing compositions, which are already employed commercially in an anti-wetting role, it is perhaps unlikely that the alloy compositions quoted in this paper will find practical application. Nevertheless, careful consideration of the predictive possibilities opened up by the correlations which the authors suggest between the bond parameters of metals and their wetting behaviour may open up some new avenues for alloy development. G.L.S.