Product Data Sheet

MCP 137/Metspec 281 Alloy

UPDATED ON 2012-07

TYPICAL USES

The principal uses of the alloy depend on the density difference between liquid and solid and the dimensional changes after solidification being both very small, the actual magnitude of the latter depending on the dimensions and thermal treatment of the material. MCP 137 (otherwise referred to as Cerrotru) is suitable for such applications as precise work holding (as in the encapsulation of turbine blades, to enable the root to be machined) and "fusible core technology", where the alloy is used in a manner analogous to the 'lost wax' in investment casting. Additionally, the hardness is sufficient to permit its use in press tools, which, though rather low compressive strength restricts their life, can be used for prototype and short run production work. Other applications include proof casting, thermal fuses and lead free soldering.

PHYSICAL PROPERTIES

MCP 137 is an alloy of Bismuth (58%) and Tin. For most purposes it can be regarded as the system eutectic, to which it is certainly very close (most reported values appear in the range 57-58% Bi)(1). The solid is a mixture of the α-and β- phases, respectively the solid solutions of Bismuth in Tin and of Tin in Bismuth. In common with all alloys of low melting point, MCP 137 undergoes a slow equilibration after solidification, producing changes in physical properties. The changes may be accelerated by annealing.

Characteristic	Typical Value
Density	8.58 g/cm^3
Brinell Hardness	23
Melting Point	135°C
Specific heat at 25°C (solid)	0.167 J/g.°C
Specific heat at 120°C (liquid)	0.155 J/g.°C
Enthalpy of fusion	49.1 J/g
Electrical resistivity	59.0 mΩ.cm
Compressive Properties: Proof stress at 2 days and 70 days	
(0.2% set)	41.6 rising to 46.7 MPa
(1.0% set)	49.4 rising to 58.3 MPa
Tensile Properties: Data at 2 days and 70 days	
Proof stress 0.2% set	32.1 rising to 42.1 MPa
Tensile Strength	60.1 rising to 62.3 MPa
Elongation (% in 5.65√A)	80 falling to 55

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(1) The analytical purity is determined by ICP (Inductively Coupled Plasma)

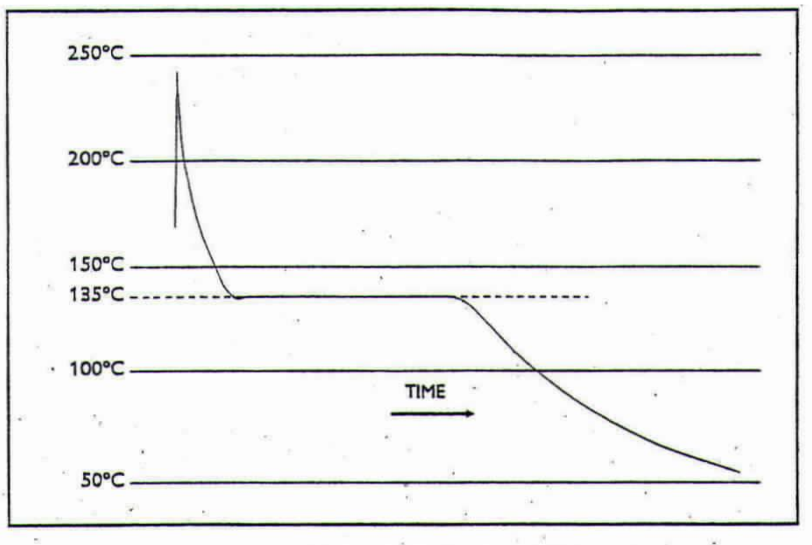

Fig. 1 SOLIDIFICATION

The trace obtained by solidification from a homogeneous melt of a sample of 300g indicates a single arrest (following slight supercooling) at about 135^{0}C. For this alloy, the level plateau defines very precisely the temperature at solidification. This temperature may be compared with those found in melting of both newly and solidified and matured samples (fig. 2).

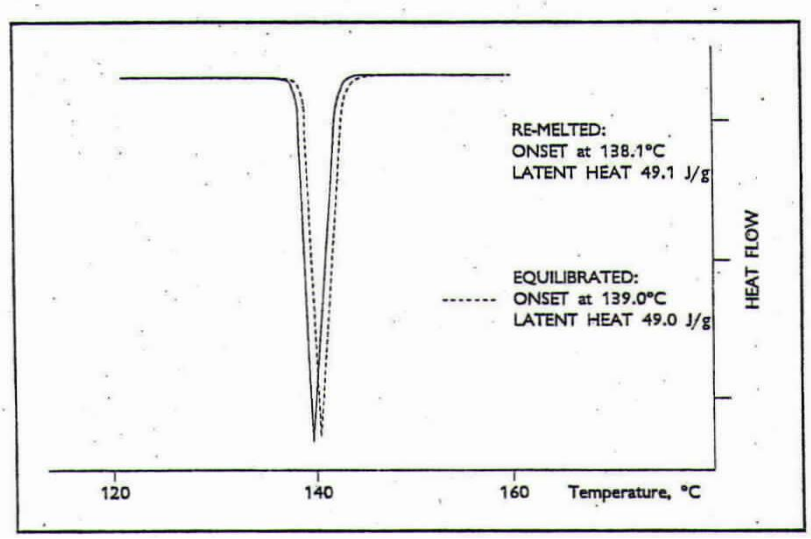

Fig. 2 MELTING

The structural changes that take place after solidification are made apparent by the technique of differential scanning calorimetry (DSC). The behavior of matured alloy is here compared with that of a newly solidified specimen.

The onset temperature for melting, like the latent heat of fusion, is found to have altered slightly in older specimens. The curves for these extremes of treatment are reproducible. The differences in melting behavior between specimens of different ages (or which have had different thermal conditioning) are insufficient to be of practical significance. The curve remains stable after the specimen has reached the 'equilibrated' condition.

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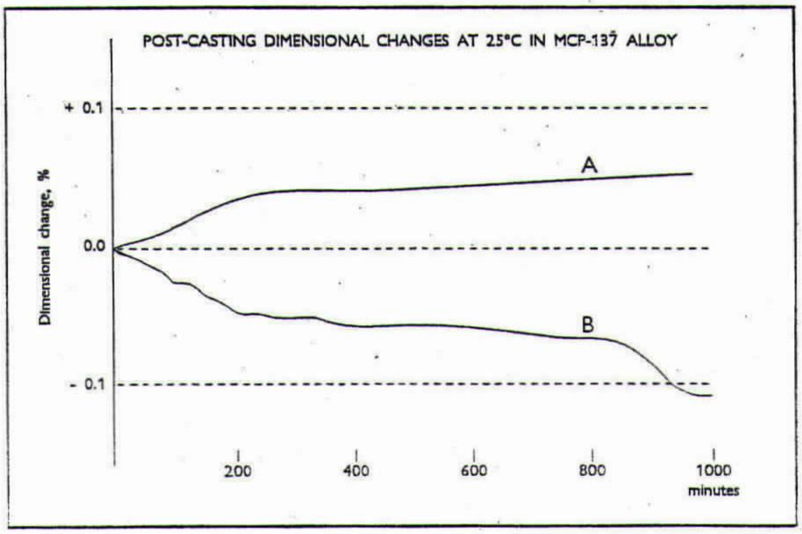
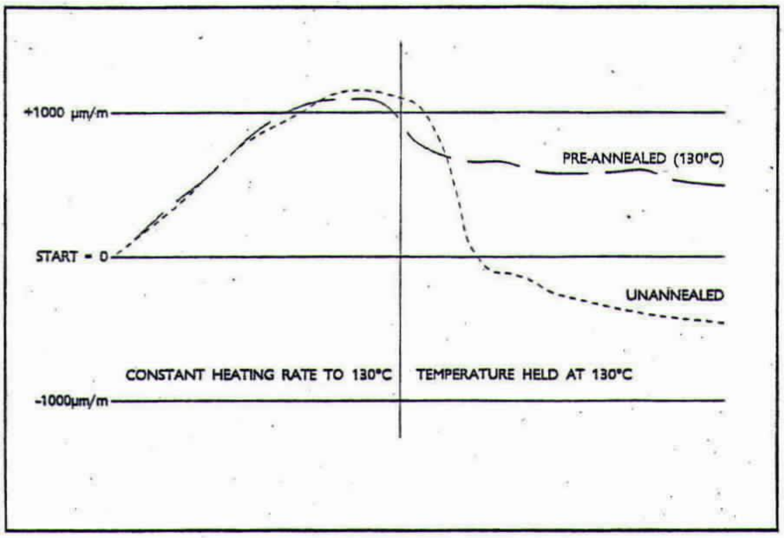
Fig. 3 GROWTH & SHRINKAGE



The linear dimensional changes after casting are sensitive to the size and shape of the specimen, which affect the rate of cooling after solidification and, in consequence, equilibration of the internal structure. The differences ultimately disappear, to be barely apparent between fully mature specimens. Curve A is for a 10mm square bar, 250mm in length, which shows a net growth of 0.055% after about 16 hours (rising to 0.10% after 6 months). The lower curve B is for a faster quenched small specimen of 5 x 5 x 2mm.

Fig. 4 THERMAL EXPANSION



The structural changes that occur in equilibrating solid alloys influence the thermal expansion. The coefficient of thermal expansion of MCP 137 is reasonably constant for almost any specimen up to about 90^{0}C, at about 16 – 17 x 10^{-6}. ^{0}C$^{-1.}$ Above that temperature, the influence of structural changes begins to predominate, resulting in net contraction which is smaller for artificially aged (i.e. annealed) specimens than for those newly cast and chilled. More prolonged annealing extends the range of constant linear expansion.

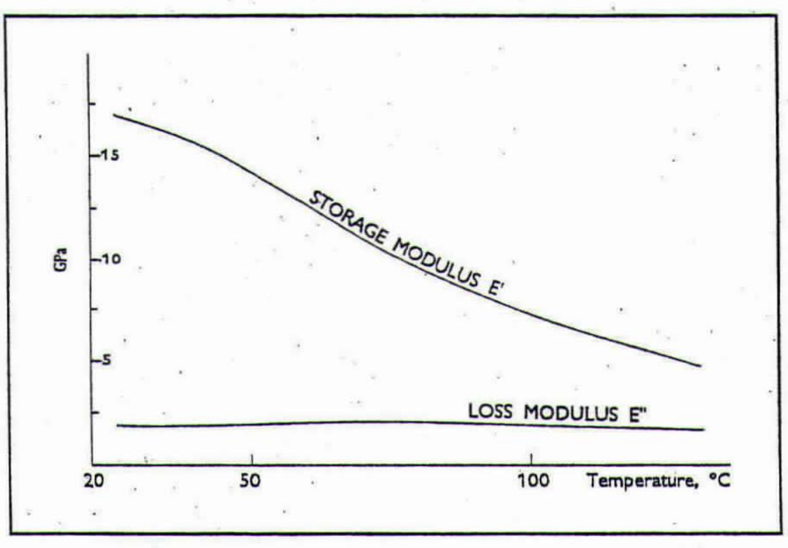


Fig. 5 ELASTICITY

The storage modulus E’ of a newly cast specimen decreases slowly with temperature, while the loss modulus E’ passes through a maximum (in the range 70-80^{0}C) which itself tends to increase as the specimen ages. The storage modulus is stable during isothermal holds. Annealing at 130^{0}C significantly raises the subsequent elasticity at 20^{0}C.

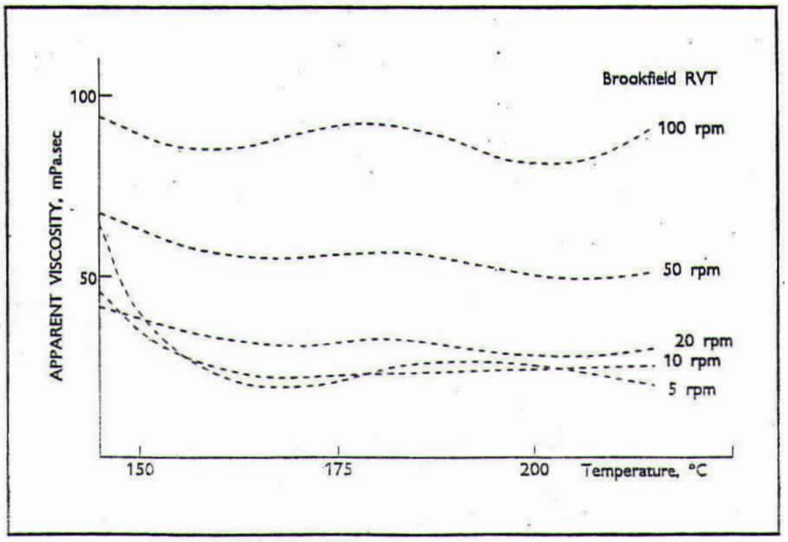


Fig. 6 VISCOSITY

Like that of most fusible alloys, the viscosity of MCP 137 is quite low and probably Newtonian. However, other effects (including high surface tension) within the working temperature range influence practical measurements, falsely suggesting non-Newtonian behaviour. The values indicated in the diagram were obtained by means of a Brookfield RVT viscometer, using 3 litres of liquid alloy in a cylindrical container with alloy depth being roughly equal to diameter. The figure illustrates changes apparent under conditions such as might be encountered in practical use. Viscosity is, in fact, so low that it is rarely a serious consideration in designing systems in which large quantities of alloy are circulated.

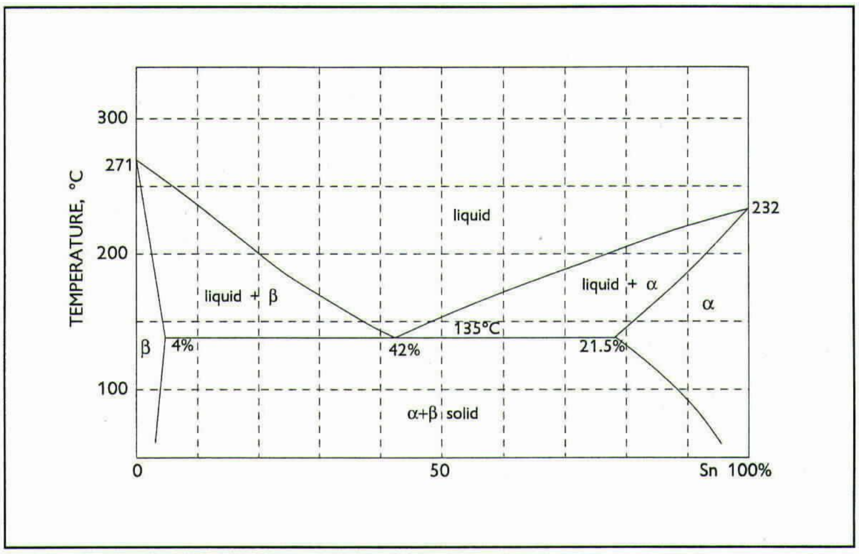


Fig. 7 THE BISMUTH-TIN PHASE DIAGRAM

The diagram is based on published data (e.g. M.Hansen & K. Anderko, ‘constitution of Binary Alloys;’ C.J. Smithells, “Metals Reference Book”). There is a slight uncertainty in the eutectic composition, with most reports in the range of 42-43% Tin.

The Alloy MCP 137 contains 42% Tin.

STORAGE AND USE

Store products in their original packaging.
Wear protective equipment recommended by the Safety Data Sheet.