A Technique for Growing Single Crystals of CuAu

During a recent investigation on the stress-order effect in CuAu [1], we required to grow a large number of reasonably perfect single crystals of CuAu. Though several investigations [2-4] in the past appear to have been carried out on single crystals of CuAu, no information as to the exact technique adopted for the growth is available. This is of concern as there have been reports [5] of macroscopic bending and fracture of single crystals during growth.

A modified Bridgman technique was first adopted for growing the single crystals. An evacuated silica tube, containing a split-graphite mould loaded with previously melted CuAu, was allowed to travel downwards in a gradient furnace maintained at about 1050° C. The speed of the downward travel was maintained fairly low (about 6 cm/h) in an effort to grow good crystals. Experiments carried out in this way yielded highly strained, bent, and heavily twinned crystals. In fact, some of the crystals were found fractured inside the crucible itself. Fig. 1 shows a macrograph of such a distorted crystal obtained during one such experiment.

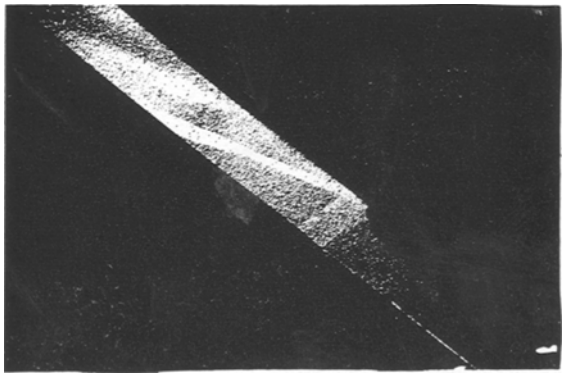

Figure 1 Macrograph of CuAu crystal grown by conventional Bridgman method (× 1.5).

Such behaviour is understandable, since the ordering reaction (below 420° C) for this composition is accompanied by a large distortion of the lattice. Further, this transformation involves twinning on both {101} and {111} plane Though {101} twins disappear when the crystal is subsequently disordered, {111} twins remain, destroying the uniformity of the crystal.

Because of the presence of these imperfections induced by ordering, we decided to grow crystals in such a way that the crystals did not enter the ordered tetragonal or orthorhombic phase fields during growth. This was accomplished by growing the crystals in a two-zone furnace. The top zone was maintained at 1050° C while the bottom zone was kept at 800° C, which is below the melting point but above the critical temperature for ordering. In order to achieve optimum conditions for the growth, the speed was adjusted to about 8 mm/h. The graphite crucible, as before, was sealed inside a silica tube which was narrowed at the bottom to a fine capillary. The silica tube containing the crucible was then lowered by the motor till the second zone was reached and was kept in this zone for about 20 h to homogenise the crystal. Later, the capillary of the silica tube which was projecting from the bottom of the furnace was broken, and water was allowed to rush into the tube and quench the crystal. This method has the advantage that since the crystal has never been ordered at any stage during growth, the distortion associated with the ordering transformation is entirely avoided. Both microscopic and X-ray investigations have shown these crystals to be uniform and substantially strain-free, and they were not bent or fractured.

Since this work was done, we have learned [6] that a somewhat similar technique has long been used to produce crack-free polycrystalline alloys of composition near CuAu for use as dental alloys.

References

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