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Solidification Behaviour of the Ni-modified Sn-0.7Cu Eutectic

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Many of the features of the “63/37” tin-lead alloy that have made it such a successful solder for the electronics industry result from the fact that it is a simple binary alloy that behaves nearly perfectly as a eutectic over a wide range of cooling rates. By contrast most of the alloy systems that have been proposed as potential lead-free solders, even those such as Sn-0.7Cu and Sn-3.8-3.9Ag-0.6-0.7Cu that are of nominally eutectic composition, do not behave in that way. While “63/37” transforms directly from liquid to solid eutectic the freezing of the eutectic phase in these lead-free solders is preceded by the precipitation of a network of primary tin dendrites. Features that arise from that difference include the notorious grainy and often cracked finish of some lead-free solders, sensitivity to contamination and poor flow during soldering processes. It has been found that these alloys behave more like the eutectic that they are supposed to be when there is a trace addition of a modifying element and alloys based on that empirical observation are now amongst the most widely used lead-free solders.
Further optimisation and development of this modification process requires an understanding of the underlying mechanism and in the studies reported in this paper techniques developed for the study of solidification mechanisms in metal casting have been applied to Sn-0.7Cu alloys with varying levels of Ni addition. Initial results of these studies have confirmed that with the optimum level of Ni the alloy does behave more like a true eutectic. In the work reported in this paper the effect of the Ni additions has been studied by measuring fluidity and dendrite coherency. These results when combined with detailed metallography go one step further in providing a scientific basis for the further development of lead-free solders.