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The Fluidity of the Ni-Modified Sn-Cu Eutectic Lead-free Solder

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One of the factors that has contributed to the establishment of the Ni-modified Sn-Cu eutectic as one of the major alternatives to the widely promoted Sn-Ag-Cu alloys as an RoHS compliant lead-free solder has been its apparent fluidity at temperatures close to its 227°C melting point. This fluidity results in the alloy behaving similarly to lower melting point alloys in which tin dendrites start to freeze out at temperatures higher than the nominal melting point. This in turn has meant that the Ni-modified Sn-Cu eutectic can be used as a wave solder and a HASL alloy at process temperatures not much higher than those that have been used with Sn-37Pb solder. More recently it has been found that this fluidity also permits the use of the alloy in reflow soldering with peak temperatures around 245°C, which is in the middle of the range used with the Sn-Ag-Cu alloys that have a nominal melting point 10°C lower. In a study reported at APEX 2005 it was found that the Ni addition has the effect of suppressing the formation of pro-eutectic β-tin dendrites in the cooling Sn-0.7Cu alloy and promoting solidification as a true eutectic and it was inferred that it was because of this effect that the alloy exhibited good fluidity close to its melting point. In the study to be reported in this paper the fluidity of the modified and unmodified Sn-0.7Cu alloys is compared using two techniques recognised in solidification science. The Ragone method measures the distance that the molten alloy flows along a tube, a situation which to some extent simulates through-hole penetration in wave soldering and metallography of the resulting sample provides a further correlation between the observed behaviour and the resultant microstructure. The Dendrite Coherency method provides a means of confirming the change in solidification mechanism to heterogenous nucleation when the Ni is present. The results of these tests are consistent with observed positive effect of the Ni in enhancing the performance of the Sn-0.7Cu alloy as a practical lead-free solder.