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Influence of solidification parameters and solute content on the machinability of two lead-free solder alloys

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Since the beginning of the last decade, lead-containing solders have been under increasing pressure from regulatory laws, as this element is harmful to human and environmental health. There is, therefore, a search for an alloy that replaces the Pb-Sn system and presents the same mechanical and manufacturing characteristics that make lead-based alloys one of the most used in electrical circuits today. Preliminary studies suggest that Sn-Sb alloys are promising alternatives for replacing lead-containing solder alloys. However, it is necessary to evaluate manufacturing characteristics and solute contents that make them suitable for replacement. In this sense, this work makes a correlation between solidification parameters (i.e., growth and cooling rates and primary dendrite arm spacings) and machinability of Sn-2.0wt%Sb and Sn-5.5wt%Sb alloys, solidified in a horizontal directional device, evaluating the influence of solute content on these results. Therefore, cutting temperatures were measured by infrared thermometers in dry necking processes along the length of the ingot. After the analyses, it was observed that the reverse cellular-dendritic transition influenced the cutting temperature results, preventing the proposition of a law that correlates cutting temperature with solidification parameters along the entire ingot. The range of cell and dendrite spacings varies approximately from 40 to 330 ?m on the Sn-2.0wt%Sb alloy and from 15 to 240 ?m on the Sn-5,5wt%Sb alloy. In the cellular region, higher cutting temperature values are found for the Sn-5.5wt%Sb alloy, but in the dendritic region, these values were higher for the Sn-2.0wt%Sb alloy. Such results are probably because of the occurrence and quantity of the soft ?-Sn phases resulting from the Sn segregation.