Thermal Diffusivity Measurements of Lead-free Alloys

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We have developed a methodology for determining thermal diffusivities of a wide range of materials. Thermal diffusivities are determined by using temperature measurements at two locations in a disk-shaped sample. The technique is based on an analytical solution of heat transfer in a circular cylinder. This methodology does not require knowing the initial temperature increase, the amount of heat generated, or any timing between the applied and measured response. Starting with a cylinder heated on the outer surface and unique temperature measurement locations, the analytical solution for temperature at two specific radii can be approximated, after an initial transient, by a constant plus a single term that decreases exponentially with time. There are two special radii that fulfill the required condition. The data are analyzed by taking logarithms of the differences of the temperature versus time at these two radii, resulting in lines having slopes that are proportional to the thermal diffusivity. Using this methodology we have determined the thermal diffusivities of 308 ($Ag_{0.03}Cu_{0.005}Sn_{0.965}$), 405 ($Ag_{0.04}Cu_{0.005}Sn_{0.955}$), and 3807 ($Ag_{0.038}Cu_{0.007}Sn_{0.955}$) lead-free alloys. Thermal diffusivities for these alloys were measured between room temperature and 100ºC. The alloys, which are primarily tin, showed different temperature dependencies.