“Crystal Plasticity Finite Element Analysis of Deformation Behavior in SAC305 Solder Joints”

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Due to the awareness of the potential health hazards associated with the toxicity of lead (Pb), actions have been taken to eliminate or reduce the use of Pb in consumer products. Among those, tin (Sn) solders have been used for the assembly of electronic systems. Anisotropy is of significant importance in all structural metals, but this characteristic is unusually strong in Sn, making Sn based solder joints one of the best examples of the influence of anisotropy. The effect of anisotropy arising from the crystal structure of tin and large grain microstructure on the microstructure and the evolution of constitutive responses of micro scale SAC305 solder joints is investigated.

Insights into the effects of key microstructural features and dominant plastic deformation mechanisms influencing the measured relative activity of slip systems in SAC305 are obtained from a combination of optical microscopy, orientation imaging microscopy (OIM), slip plane trace analysis and crystal plasticity finite element (CPFE) modeling.

Package level SAC305 specimens were subjected to shear deformation in sequential steps and characterized using optical microscopy and OIM to identify the activity of slip systems.

X-ray micro Laue diffraction and high energy monochromatic X-ray beam were employed to characterize the joint scale tensile samples to provide necessary information to be able to compare and validate the CPFE model.

A CPFE model was developed that can account for relative ease of activating slip systems in SAC305 solder based upon the statistical estimation based on correlation between the critical resolved shear stress and the probability of activating various slip systems.

The results from simulations show that the CPFE model developed using the statistical analysis of activity of slip system not only can satisfy the requirements associated with kinematic of plastic deformation in crystal coordinate systems (activity of slip systems) and global coordinate system (shape changes) but also this model is able to predict the evolution of stress in joint level SAC305 samples.

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