Molecualr Dynamics Study on the Strain Rate-Dependent Tensile Deformation and Failure Behavior of Single-Crystal β-Sn

Xiaoyuan Wang*[1]

[1]East China University of Science and Technology – China

Abstract

Lead-free solder, particularly β-Sn, is critical for maintaining the structural integrity and functional reliability of integrated circuits. Understanding the mechanical properties and fracture behavior of β-Sn is therefore of great significance. In this study, molecular dynamics simulations using the modified embedded atom method were conducted to explore the mechanical properties and crack propagation of single-crystal β-Sn under varying strain rates. The results reveal that with increasing strain rates, single-crystal β-Sn exhibits higher yield strength, fracture strength, and fracture strain, accompanied by a decrease in elastic modulus. At elevated strain rates, pronounced strain hardening occurs due to a significant increase in internal dislocation density, which inhibits plastic deformation. These findings provide atomic-level insights into the strain-hardening mechanism and enhance the understanding of the mechanical behavior of single-crystal β-Sn. This study offers valuable guidance for optimizing the design and application of lead-free solder materials in the electronics industry.

*Speaker