25th International Conference on Electronic Packaging Technology
August 07 to 09, 2024, Tianjin, China
http://www.icept.org

Speech subject： Thermo-mechanical fatigue life prediction of SiC power device based on finite element simulation

Speech leader: Dao-Hang Li—Research Assistant, Tiangong University

Speech Description/Objective:

This paper establishes a prediction method for the thermo-mechanical fatigue life of SiC power devices based on electro-thermal-mechanical coupling finite element simulation. The Anand constitutive model is used to describe the cyclic mechanical behavior of sintered silver at high temperature, and the Coffin-Manson equation is used to evaluate the thermo-mechanical fatigue damage of sintered silver. Firstly, a non-contact strain measurement and control technology is developed. Secondly, this paper conducted static shear tests on sintered silver interconnect specimens at different strain rates and temperatures, and found that the shear strength of the material decreases with decreasing shear strain rate and decreases with increasing temperature. Moreover, the material constants of the Anand constitutive model for sintered silver were identified based on the static shear stress-strain curve. Thirdly, cyclic shear tests were conducted on sintered silver interconnect specimens, and finite element simulation of the tests were also conducted. The effectiveness of the simulation was verified by comparing the experimental and simulated stress-strain results. Afterwards, the electro-thermal-mechanical coupling finite element simulation of a SiC power devices under power cycling was conducted, and the key dangerous parts of the device under power cycling were identified, then the stress-strain response history of the key dangerous parts was further extracted. Finally, the Coffin-Manson equation was used to calculate the thermo-mechanical fatigue damage and predict the failure life of SiC power devices. By comparing the experimental and predicted life results, it was found that the prediction error was within a factor of 2, indicating that the established method can provide satisfactory prediction results and provide key technical support for the fatigue life design of SiC power devices.

Speech Outline:

① Introduction
② Strain-Controlled Shear Test
③ Identification of Material Constants of Anand Constitutive Model
④ Established Thermomechanical Fatigue Life Prediction Method
⑤ Conclusions

Who Should Attend:

Scholars interested in fatigue life prediction of power electronic devices.

Introduction of Speaker:

Dao-Hang Li, male, 31 years old, research assistant at Tiangong University, mainly engaged in research on fatigue life prediction of power electronic devices and the impact of sintering process on power electronic device packaging. Published 10 SCI papers as the first author, including 8 papers in JCR Zone 1 and 5 papers in TOP journals, including authoritative journals in the field such as International Journal of Mechanical Sciences, Materials Science and Engineering: A, and International Journal of Fatigue. Published more than 30 SCI papers with 267 citations and an h-factor of 9. Participated in the formulation of 2 national standards, granted 18 invention patents,

and granted 2 software copyrights. Hosted 1 funding support for postdoctoral research activities in Beijing, 1 funding support for postdoctoral research activities in Chaoyang District, and participated in 8 research projects. In addition, he has been awarded the Excellent Doctoral Dissertation in Beijing, the National Scholarship for Doctoral Students by the Ministry of Education of the People's Republic of China, and the Scholarship for the National Construction of High-Level University Public Graduate Project by the China Scholarship Council.