Title: Reliability and lifetime estimation of power electronic modules under high temperature loading conditions
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Abstract: Advanced packaging technologies are currently being designed and developed by the power electronics industry however, the maximum operating temperature is still limited to 175°C for the silicon carbide devices. Bonded materials such as sintered silver, sintered copper, and polymeric materials are potential candidates for high temperature operation, but it is critical to characterize and evaluate its reliability under harsh operating conditions. In the first part of this webinar, the accelerated experiments and thermomechanical modeling results of these bonded materials, and their lifetime prediction models developed at the National Renewable Energy Laboratory (NREL) are discussed. Failure mechanisms that occur within these materials are identified through destructive evaluations. In the second half, the modeling approach adopted at NREL to create a design-for-reliability framework to optimize various power module configurations is presented. Although the initial focus in creating this framework is focused only on thermal and thermomechanical objectives, the end-goal is to consider the multiphysics environment and create an application that engineers and researchers can leverage to rapidly identify opportunities to improve the lifetime of power electronic modules.

Bio: Paul Paret is a researcher in the Center for Integrated Mobility Sciences at the National Renewable Energy Laboratory. In this role, Paul leads the computational modeling efforts to simulate the thermal and thermomechanical behavior and develop lifetime prediction models of various bonded materials in power electronics packages used in electric-drive vehicles and aviation systems. He conducts design optimization studies to identify the optimal component layers and geometry within power electronics package topologies to improve their power density, efficiency, and reliability. Additionally, he performs reliability evaluation experiments to identify the fundamental failure mechanisms of materials under harsh operating conditions. Paul has published several articles including journals, conference papers, technical reports, and a book chapter on the thermomechanical performance and lifetime prediction models of power electronics materials. Paul has a Master’s degree in Aerospace Engineering from the University of Colorado, Boulder and a bachelor’s degree in Mechanical Engineering from College of Engineering, Trivandrum, India. He is an ASME member and an IEEE Senior Member.