

PhD Dissertation Defense Announcement

Mechanical and Aerospace Engineering Department

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Investigation of the Impact of Material Models on Reliability Assessment of Electronic Packages By

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Abstract

Drop testing, thermal cycling, power cycling, etc. are some of the tests used to assess the reliability of new electronic products. However, performing experimental study of every new design is costly and time consuming. Computational tools are often employed to perform the required reliability analysis in a shorter time period and save valuable resources. Extensive set of material characterization work needs to be done before an accurate material model can be developed and used in computational analysis. Structural components such as printed circuit boards (PCBs) are critical in the thermomechanical reliability assessment of electronic packages. The bulk material properties of PCBs are commonly characterized using equipment such as tensile testers and used in computational studies. However, if a detailed layer by layer model is required for the study, it is often difficult to obtain location dependent mechanical properties for a given woven glass/epoxy substrate. In this work, nanoindentation technique is used to measure the modulus and creep behavior for a specific layer in the PCB

stack-up. Using measurements at room temperature, the effects of surface roughness, hold time, and maximum load on measurement values are examined. Moreover, frequency domain master curve results from dynamic mechanical analysis are used to obtain Prony series terms and perform finite element analysis on the impact of adding viscoelastic properties of PCBs when performing reliability assessment under thermal cycling and under drop testing loads for wafer level chip scale packages. Another important component of electronic packages that are presented here are thermal interface materials (TIMs). Most of the study in the literature focuses on studying the changes in thermal properties, and there is a lack of understanding when it comes to studying the mechanical behavior of TIMs. Degradation of mechanical properties is the cause for the loss in thermal performance and is critical during TIM selection process. Moreover, mechanical properties such as modulus and thermal expansion coefficient (CTE) are critical to assess performance of TIMs using finite element analysis (FEA) and potentially save time and money in the evaluation and selection process. In this work, commercially available TIMs are studied using TMA, DMA, and FTIR to evaluate the changes in mechanical properties due to thermal aging. In the last chapter of this work, the effect of parameters such as temperature curing profile, application of pressure during curing, and sample preparation technique on temperature dependent thermo-mechanical properties of die attach elastomers is investigated. The mechanical properties, including elastic modulus (E), coefficient of thermal expansion (CTE), and the glass transition temperature (T_g) of the die attach material are measured using a suite of techniques such as dynamic mechanical analysis (DMA) and thermomechanical analysis (TMA). The analysis is performed for a wide temperature range corresponding to typical MEMS sensor applications. It is shown that sample preparation and characterization techniques have a considerable impact on the measurements which results in different MEMS sensor performance predictions through computational modeling.