Effect of the viscoelastic behavior of the composite substrates on the thermomechanical modeling of a printed circuit board

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Abstract

Printed circuit boards (PCBs) are complex assemblies of materials with very different thermomechanical behaviors. Under thermal loads (environmental or self-heating), the differences in coefficients of thermal expansion induce mechanical stresses that can lead the structure to failure (1).
In order to predict their service life or understand the origin of failures, it is interesting to model these structures in operation, including their manufacturing process. The characterization of the thermomechanical behavior of the materials that constitute PCBs is hence necessary.

Insulating substrates are composite materials made of a glass fabric and a thermosetting resin. The behavior of glass is very little dependent on temperature on the given range of interest (approximatively -50○C to 200○C). It is well described by an elastic model. The behavior of the resin is, however, very influenced by temperature, in particular when approaching its glass transition temperature (Tg). The resin response is also time dependent and a thermo-viscoelastic model is required to rationalize its behavior (2). This time and temperature dependence is inherited at the composite level, with an additional complexity: the reinforcement (woven glass fibers) leads to anisotropic behavior.
In multilayer PCBs, burried holes are often encountered to transmit electrical information between inner layers. In the present work, a buried hole structure is modeled under cyclic environmental loadings by integrating the thermo-viscoelastic behavior of the identified composite (3). The main outcome of the work is tha it is essential to take into account the effects of temperature on the behavior of materials if predictive simulations are to be performed. Viscous effects become significant at temperatures close to the Tg, but can be neglected if the maximum temperature excursion remains more than 30○C below the Tg.

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