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Characterization of Thin Woven Composites Used in Printed Circuit Boards by Combining Numerical and Experimental Approaches

Authors : Gautier Girard, Marion Martiny, Sebastien Mercier, Mohamad Jrad, Mohamed-Slim Bahi, Laurent Bodin, Francois Lechleiter, David Nevo, Sophie Dareys

Abstract : Reliability of electronic devices has always been of highest interest for Aero-MIL and space applications. In any electronic device, Printed Circuit Board (PCB), providing interconnection between components, is a key for reliability. During the last decades, PCB technologies evolved to sustain and/or fulfill increased original equipment manufacturers requirements and specifications, higher densities and better performances, faster time to market and longer lifetime, newer material and mixed buildups. From the very beginning of the PCB industry up to recently, qualification, experiments and trials, and errors were the most popular methods to assess system (PCB) reliability. Nowadays OEM, PCB manufacturers and scientists are working together in a close relationship in order to develop predictive models for PCB reliability and lifetime. To achieve that goal, it is fundamental to characterize precisely base materials (laminates, electrolytic copper, …), in order to understand failure mechanisms and simulate PCB aging under environmental constraints by means of finite element method for example. The laminates are woven composites and have thus an orthotropic behaviour. The in-plane properties can be measured by combining classical uniaxial testing and digital image correlation. Nevertheless, the out-of-plane properties cannot be evaluated due to the thickness of the laminate (a few hundred of microns). It has to be noted that the knowledge of the out-of-plane properties is fundamental to investigate the lifetime of high density printed circuit boards. A homogenization method combining analytical and numerical approaches has been developed in order to obtain the complete elastic orthotropic behaviour of a woven composite from its precise 3D internal structure and its experimentally measured in-plane elastic properties. Since the mechanical properties of the resin surrounding the fibres are unknown, an inverse method is proposed to estimate it. The methodology has been applied to one laminate used in hyperfrequency spatial applications in order to get its elastic orthotropic behaviour at different temperatures in the range [-55°C; +125°C]. Next; numerical simulations of a plated through hole in a double sided PCB are performed. Results show the major importance of the out-of-plane properties and the temperature dependency of these properties on the lifetime of a printed circuit board. Acknowledgements—The support of the French ANR agency through the Labcom program ANR-14-LAB7-0003-01, support of CNES, Thales Alenia Space and Cimulec is acknowledged.

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