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Experimental and numerical characterization of thin woven composites used in printed circuit boards for high frequency applications

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Abstract

The elastic orthotropic behavior of thin woven composites is studied combining a numerical and experimental strategy. For thin materials, in-plane properties are measured by classical tensile tests and digital image correlation. The out-of-plane properties are derived performing finite element simulations at the level of the internal structure of the laminate. Indeed, the glass fiber arrangement in the yarn and the weaving pattern are defined based on microtomography and SEM observations. So a representative unit cell is found. A statistical approach is further proposed to derive the behavior of the warp and fill yarns, since the fiber position may fluctuate between yarns. For the considered laminate, the matrix (resin and ceramic inclusion) behavior is unknown and difficult to measure. Therefore an inverse method is proposed. By comparing with measured in-plane elastic moduli, behaviors of the matrix, of yarns and of the laminate are defined. The present homogenization strategy is exemplified by laminates used in printed circuit boards for high frequency applications. This approach has also been applied to investigate the evolution of the elastic moduli of the laminate with temperature. Those information, usually not available in the literature, are important when dealing with reliability of printed circuit boards during thermal cycles.

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