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On the investigation of experimental and numerical methods to characterise the fracture behaviour of epoxy resins: an approach to prevent failure in electronic component

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Prediction of crack growth in encapsulating material has a critical issue on the reliability of electronic components. To prevent the risk of material rupture or to extend the lifetime of these structures, experimental and numerical methods are developed within the context of linear elastic fracture mechanics. The present study proposes to extend techniques, which were previously established for metals, to epoxy resins. First, an experimental procedure using compact tension (CT) specimens is applied to characterise the fracture toughness of epoxy resins. The test dispersion is estimated with a statistical method based on a Weibull distribution. This technique is then used to compare different epoxy resins and to quantify effects due to presence of filler particles. The influence of the temperature is also described. Hereafter, a method is proposed to determine a fracture criterion for cracks under mixed mode loading. Experiments are performed on centre cracked tension (CCT) specimens. This geometry additionally enable to extract the direction of crack propagation for given proportions of tensile and shear loading. Based on finite element methods, a numerical analysis is used to calculate the direction of crack propagation. A comparison between experimental and numerical results confirms the capability of FE codes to predict curved crack path. As well, fatigue crack growth is investigated with CT specimens under cyclic loading. Material parameters are identified in accordance with the Paris law. With the help of the commercial software Zencrack, a crack propagation can be simulated by a sequential approach, in which the crack length is updated step by step. 2D and 3D models are generated.

The influence of the crack curvature through the thickness is described. On that purpose, a modified Paris law is proposed. The simulated crack propagation provides excellent agreements with experimental measurements