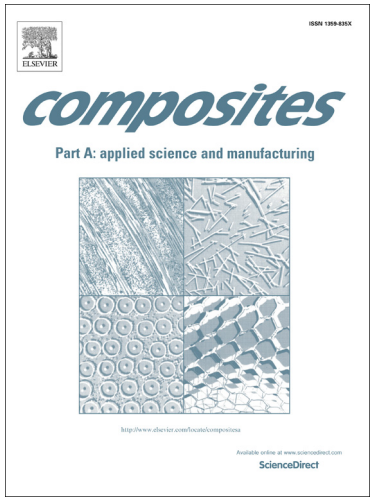

Effect of voids on the crack formation in a $[45/-45/0]_s$ laminate under cyclic axial tension

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Abstract

In the present work, the influence of manufacturing induced voids on damage mechanisms at the microscopic scale was analysed on $[45/-45/0]_s$ laminates subjected to tension fatigue loading. Microscopic observations of the top surface of the 45° ply revealed that the first event of damage at the microscopic scale was the initiation of multiple micro-cracks in the matrix between the fibres, located preferentially in correspondence of the voids in that layer. The subsequent coalescence of these micro-cracks gave rise to the formation of a macro-crack propagating in the 45° fibres direction. This is qualitatively the same scenario observed in void-free specimens in a recent work by the authors, thus confirming that the same crack initiation criterion can be applied in the absence and presence of voids. In addition, the micro-scale damage is shown to evolve faster and therefore macro-cracks to initiate earlier and in a larger quantity in the presence of voids.

1. Introduction

The high specific properties of polymeric composite materials can be strongly influenced by the presence of defects, such as voids, that originate during the manufacturing process (see Ref. [1-4] among the others). Voids can be generated due to inaccuracies in the manufacturing process but also due to the very nature of the materials involved. Indeed, voids might form due to the release of volatile compounds during the resin cure, and, in processes that involve liquid resin (infusion, RTM), to the different flow velocity inside and outside the fibres bundles. This makes it difficult and costly to manufacture defect-free composite components.