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COMBINED MACRO- AND MICRO-MECHANICAL ANALYSIS OF THE FRACTURE BEHAVIOR IN INTERLAMINAR FRACTURE TOUGHNESS TESTS

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Consolidated continuous fiber reinforced thermoplastic tapes have recently been used for lightweight structural parts as well as light-weight patching material to locally reinforce a specific part area. The manufacturing process of such parts requires the pre-consolidation of the raw tape material, which consists of three steps: tape laying, heating, and compression of the tape layers. It is important to understand how this manufacturing method affects interface microstructures and their mechanical properties, in particular, delamination fracture toughness between the tape layers. However, fracture toughness experiments rely on the measurement accuracy of a propagating crack, which can be decreased due to stepwise and abrupt crack propagation, crack branching, or fiber bridging, for example. Hence, the experiment evaluation regarding the material's critical energy release rates can become imprecise and can result in highly scattering data. By means of a reverse simulation approach considering the macromechanical material behavior as well as its micromechanical crack initiation and propagation schemes, the experiment evaluation can be refined in order to obtain a better understanding of the material's failure behavior. Therefore, a virtual microstructure statistically representing the real microstructure is generated using a Voronoi algorithm and implemented as a sub-model within a FEM model of a macroscopic fracture toughness specimen. The virtual microstructure consists of several cells, each representing fiber rich or fiber poor areas of the actual material, with homogenized material properties as a function of the corresponding fiber volume fraction. With this model, the inverse simulation approach shall help evaluating the fracture toughness experiments in order to obtain reliable material model parameters necessary for the further part development process.

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