CHARACTERIZATION OF INTERLAMINAR FRICTION DURING FORMING PROCESSES OF THERMOPLASTIC CFRP MATERIALS

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This paper describes the experimental work carried out to characterize the interlaminar friction phenomena during dynamic forming processes for thermoplastic composites materials. First, Differential Scanning Calorimetry (DSC) and Dynamic Mechanical Analysis (DMA) were conducted to study the microstructural behaviours of both target materials: UD PEEK (Polyetheretherketone) and UD PAEK (Polyaryletherketone) prepregs. Second, a set of experiments inspired by the work of Murtagh [1], Vanclooster [2], and Sachs [3] was performed to obtain the dependency of the different parameters, such as temperature, pressure, and pulling rate on the interlaminar friction coefficient and shear stress.

The proposed experimental process was a horizontal pull-out fixed-plies test. This rig consisted of pulling out a ply that lays in between two fixed plies. A machine applied a relative sliding motion between the middle ply and the fixed ones by loading the system in tension while a normal force was applied. A load cell was placed between the clamping and the pulling machine to measure the friction force.

Temperatures were selected according to relevant changes on the materials' microstructure observed in the preliminary DSC and DMA tests. Thus, points between ambient and forming temperatures were tested. The objective was to determine the dry and the hydrodynamic friction characteristics.

Results showed that both materials produced comparable responses to variations in temperature, pulling rate, and pressures. Friction coefficients and shear stresses of these materials exhibited similar tendencies at a temperature below the melting point. However, above these temperatures, PEEK showed a more liquid-like behaviour while the PAEK seemed to be a more viscous material.

Finally, two empirical models have been proposed to predict the interlaminar behaviour of both materials within the range of testing conditions. These models could help to improve the understanding of the thermoplastic properties as well as be part of bigger models that may allow the simulation of some forming processes.

References

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