Parametric Study in Co-Extrusion-Based Additive Manufacturing of Continuous Fiber-Reinforced Plastic Composites

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ABSTRACT

The main objective of this research work was to investigate the designed geometry and process parameters in a dual matrix composite filament co-extrusion technology (CFC), a co-extrusion of continuous pre-impregnated thermoset (1.5K) carbon fiber- reinforced filament with a special binder thermoplastic filament.

Accordingly, Non-isothermal fluid flow, fluid-structure interaction, and particle tracking analysis were employed in order to examine the melt flow dynamics and concentricity of the pre-impregnated thermoset fibers within the binder thermoplastic material. In addition, critical parameters like pressure drop, velocity and temperature distribution, shear stress, residence time, and swelling/shrinkage ratio were evaluated.

In particular, the computational fluid dynamics simulations indicates distresses in the conventional die design, recirculation and stagnation of melt flow in the dead zones causing longer melt residence leading to the thermal degradation of thermoplastic material.

Furthermore, a new die was designed to expedite the solution for the possible flow instabilities that may lead to a disparity in the material and mechanical properties, a side- fed mandrel die was used as a melt distributor. Consequently, the side- fed mandrel die ensured a homogeneous melt distribution inside the CFC print head, particularly at the die exit.