RESIN TRANSFER MOLDING OF ANIONICALLY POLYMERISED POLYAMIDE 12

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ABSTRACT

Resin Transfer Molding is traditionally reserved to thermoset matrix composites, where it finds a wide number of applications. For thermoplastic matrices, this technique is in general not possible because of the high viscosity of the matrix, and solvent processing would be possible but is not environmentally acceptable. The anionic polymerization of Lactam 12 (APLC12), using a liquid activator and catalyst system to form Polyamide 12 opened new perspectives, as the low viscosity monomer and activator system can be mixed and injected as in conventional RTM, to further polymerize and yield PA12 matrix composites.

Although very similar in concept to thermoset RTM, the APLC12 process raises a number of specific issues, which are reviewed based on recent research at LTC on infiltration of APLC12 into non-crimp fabrics or satin weave carbon preforms.

Reaction kinetics and viscosity evolution with time and temperature were modeled to establish practical process windows. In addition, the polymerization and solidification shrinkage were measured, to show that no shrinkage occurs during polymerization, but about 9% is observed during crystallization. As the monomer is kept under Nitrogen, diffusion and solubility of Nitrogen in the monomer were characterized, to indicate that Nitrogen bubbling during injection is a major cause of voids in the final part. Capillary effects were shown to be significant, and to depend on the fiber preform architecture and volume fraction. Finally, the infiltration process was studied in details to assess the role of flow rate on the formation and transport of voids. Optimal flow conditions were determined to minimize void content during liquid molding and the average void content could be reduced from initially 17% to below 1% in flat composite plates. In parallel, complex shapes including thickness variations and hollow cores were successfully produced, demonstrating the strong potential of this material system.