Graduate Student Research Seminar

Spring 2023

Optimization of cure process parameters to minimize process-induced deformation through the establishment of cure cycle-laminate behavior-deformation relationship

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

The cure processing of composite structures primarily suffers from residual stress inducement through internal and external sources. The two sources of residual stress development that have received considerable attention from researchers and industry alike are the mismatch of thermal expansion coefficients and the cure shrinkage of resin. The residual stresses induced through these sources have been shown to severely compromise the strength and adversely affect the performance of the composite laminate. Experimental and numerical studies have shown that these process-induced stresses are directly influenced by the cure cycle the thermoset prepregs are subjected to. As a result, the determination of an optimum cure cycle is critical to reduce residual stresses/restrict deformation within prescribed tolerances. Only a few numerical studies are available in the literature that are focused on optimization of cure cycle parameters to minimize process-induced residual stresses/deformations. These studies have failed to explain the relationship between cure cycle parameters and induced stresses/deformations. In the present work, the laminate behavior during the cure process was studied and the relationship between the cure cycle and the occurrence of two physical phenomena, namely modulus development and cure shrinkage during the cure process was identified. The influence of these phenomena on the development of residual stresses/deformations through the underlying mechanisms of thermal and chemical shrinkage effects was established. Further, the effects of cure cycle parameters on residual stresses/deformations were demonstrated with the help of three modified cure cycles. Finally, optimum cure cycle parameters were determined that minimized deformations by assimilating the established cure cycle-laminate behavior-residual stress/deformation relationship.

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