Abstract

Fiber reinforced plastic (FRP) structures are widely used compared to metallic structures due to their superior mechanical properties and lightweight. However, anisotropy and heterogeneity inherent to FRPs cause a multitude of damage mechanisms during the life of these structures. Often, residual stresses generated in FRP structures due to mismatch in thermal properties of the constituents are not accounted for in the design phase. These cure residual stresses have known to be quite detrimental to the performance of the composite structures resulting in loss of functionality (distortions) or load-carrying capability.

The present study, investigates process induced cure residual strain (CRS) development in carbon fiber reinforced plastic (CFRP) laminates composed of different layup sequences and thicknesses. In addition, CRS development due to internal temperature gradient due to exothermic polymerization reaction within the laminate has been characterized A comprehensive experimental test methodology is developed to measure the in-situ CRS in CFRP laminates prepared by wet layup technique. To delineate the effect of anisotropy and heterogeneity exhibited by CFRPs on CRS development, detailed experimental plan of measuring in-situ CRS in pristine epoxy, unidirectional (UD)-CFRPs and multidirectional (MD)-CFRPs has been established and CRS measured. Emphasis is laid upon quantifying the variation in CRS magnitudes as a function of laminates lay-up sequence and thickness. Calibration of fiber Bragg grating (FBG) sensors are carried out by following well established procedures. Open hole tensile (OHT) tests are also conducted to correlate in-situ strains with measured surface strains using digital image correlation (DIC). Results indicate process induced CRS measured are significant that may result in laminate deformation and micro stresses causing matrix micro-cracking during curing.