World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:14, No:04, 2020

Hydrothermal Aging Behavior of Continuous Carbon Fiber Reinforced Polyamide 6 Composites

Authors : Jifeng Zhang , Yongpeng Lei

Abstract : Continuous carbon fiber reinforced polyamide 6 (CF/PA6) composites are potential for application in the automotive industry due to their high specific strength and stiffness. However, PA6 resin is sensitive to the moisture in the hydrothermal environment and CF/PA6 composites might undergo several physical and chemical changes, such as plasticization, swelling, and hydrolysis, which induces a reduction of mechanical properties. So far, little research has been reported on the assessment of the effects of hydrothermal aging on the mechanical properties of continuous CF/PA6 composite. This study deals with the effects of hydrothermal aging on moisture absorption and mechanical properties of polyamide 6 (PA6) and polyamide 6 reinforced with continuous carbon fibers composites (CF/PA6) by immersion in distilled water at 30 ℃, 50 ℃, 70 ℃, and 90 ℃. Degradation of mechanical performance has been monitored, depending on the water absorption content and the aging temperature. The experimental results reveal that under the same aging condition, the PA6 resin absorbs more water than the CF/PA6 composite, while the water diffusion coefficient of CF/PA6 composite is higher than that of PA6 resin because of interfacial diffusion channel. In mechanical properties degradation process, an exponential reduction in tensile strength and elastic modulus are observed in PA6 resin as aging temperature and water absorption content increases. The degradation trend of flexural properties of CF/PA6 is the same as that of tensile properties of PA6 resin. Moreover, the water content plays a decisive role in mechanical degradation compared with aging temperature. In contrast, hydrothermal environment has mild effect on the tensile properties of CF/PA6 composites. The elongation at breakage of PA6 resin and CF/PA6 reaches the highest value when their water content reaches 6% and 4%, respectively. Dynamic mechanical analysis (DMA) and scanning electron microscope (SEM) were also used to explain the mechanism of mechanical properties alteration. After exposed to the hydrothermal environment, the Tg (glass transition temperature) of samples decreases dramatically with water content increase. This reduction can be ascribed to the plasticization effect of water. For the unaged specimens, the fibers surface is coated with resin and the main fracture mode is fiber breakage, indicating that a good adhesion between fiber and matrix. However, with absorbed water content increasing, the fracture mode transforms to fiber pullout. Finally, based on Arrhenius methodology, a predictive model with relate to the temperature and water content has been presented to estimate the retention of mechanical properties for PA6 and CF/PA6.

Keywords : continuous carbon fiber reinforced polyamide 6 composite, hydrothermal aging, Arrhenius methodology, interface
Conference Title : ICCM 2020 : International Conference on Composite Materials
Conference Location : Tokyo, Japan
Conference Dates : April 23-24, 2020