Mechanical and interfacial property of carbon plain woven reinforced PA6 laminates

ZHAO DEFANG

Abstract

Applications of carbon-fiber-reinforced polymer (CFRP) composite materials have increased significantly in aeronautic, aerospace, energy, and automobile industries, as well as in sports and civil engineering owing to their high specific strength and modulus, light weight, and good tailoring capability. Good interfacial adhesion is required for effective stress transfer between the fibers and matrix, which has a significant effect on the overall mechanical properties and reliability of the composites. This study investigates the mechanical and interfacial property of carbon plain woven reinforced PA6 laminates. The hot-compression technique was implemented to fabricate CF/PA6 plain-woven laminates with CF/PA6 pre-impregnated tapes.

In Chapter 1, a general introduction, background and structure of this thesis are introduced as well as the necessity of the mechanical and interfacial property of carbon plain woven reinforced PA6 laminates.

In Chapter 2, quasi-static three-point bending tests and step-by-step interrupted flexural tests were carried out to characterize the flexural behavior of different types of laminates (i.e., 2, 4, 10 and 16 plies). Additionally, the failure modes observed under flexural loading were correlated with the flexural stress-deflection behavior. Incremental cyclic flexural loading tests for CF/PA6 laminates with different layers were conducted to investigate cyclic cumulative damage. Finally, the relationship between flexural strength and knee-point stress, flexural strength and initial fracture stress were examined, respectively.

In Chapter 3, PUD is used as a surface treatment agent to improve the interfacial bonding between the CFs and PA6 matrix. The CF/PA6 laminates (i.e., 9 plies) with PUD treatment were characterized by Fourier transform infrared spectroscopy (FTIR). Mechanical testing, optical observation, and scanning electron microscopy (SEM) were performed to characterize the interfacial adhesion of the composites. The effects of PUD treatment on the thermal and thermal mechanical properties were evaluated by differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), and dynamic mechanical analysis (DMA), respectively.

In Chapter 4, the CF/PA6 laminate specimens with and without PUD treatment (i.e., 9 plies) have been immersed in distilled water at 80 ℃ until 60 days. The mechanical properties were measured after accelerated aging with different exposure times to evaluate the property retention. Scanning electron microscopy (SEM) was performed to characterize the interfacial adhesion of the composites. The impact of hydrothermal aging on the thermal properties was also evaluated using differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA) measurements.

Finally, in Chapter 5, a summary of the whole thesis is concluded.