Study on the dynamic mechanical property and resin content between the fibers of carbon fiber fabric reinforced epoxy/DDS/PEK-c composites

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1. Introduction

A toughening effect of fiber reinforced thermoplastic composite remains a longstanding exploration to produce new materials demanded by aerospace field.In this article,we investigated the effects of content of a epoxy resin (E44) on the thermal, mechanical and interfacial properties of thermoplastic composite material.Towards this objective,carbon fiber fabrics reinforced PEK-c and epoxy resin composite laminates were prepared by solution-processed prepreg and hot-press moulding.The scanning electron microscope (SEM) showed the fibers were distributed uniformly among resin and no visible flaws could be detected.The results of DMA revealed that the T_g of composite laminates increased with the rise of epoxy resin.After contrast, the ratio of 0.5:9.5 performance is best.These results interrelate closely and contribute to the finally conclusion of the epoxy resin content effects on the properties of CFRP composites.

2. Experiment

Epoxy resin(E44) was dissolved in dimethylacetamide with the ultrasonic for 30 min at room temperature to obtain epoxy resin transparent solution. Adding DDS to epoxy resin transparent solution with the ultrasonic for 10 min. The dried PEK-c powder was dissolved in epoxy resin and DDS transparent solution with constantly stirring for approximate 1h at room temperature.The solid content is 20%.The solution was brushed evenly on the CF woven fabric. After drying in the air in order to make the solvent volatilization completely for 1day.

2.1 Dynamic mechanical analysis (DMA)

Dynamic mechanical analysis was performed on a TA Q800 thermal analysis with a heating rate of 5℃/min and a frequency of 1Hz. The given amplitude was 20μm and the preload was 1N. A three-point bending mode was employed with the specimen size of 60.0mm×10.0mm×2.0mm in accordance with ASTM D7028.

2.2 Scanning electron microscopy(SEM)

The cross-section and the fractured surface morphologies of the composite laminates were investigated on a scanning electron microscopy(FEI Nova Nano SEM 450).All samples were coated with gold before observation.

3. Results and Discussion

3.1 Dynamic mechanical analysis

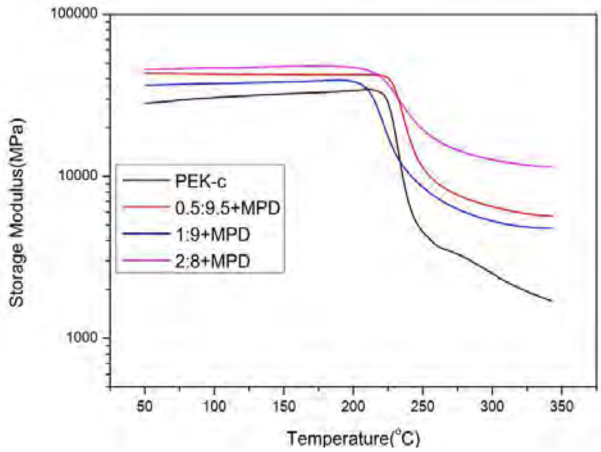

Figure 1. Storage modulus (E') curves of composites by DMA.

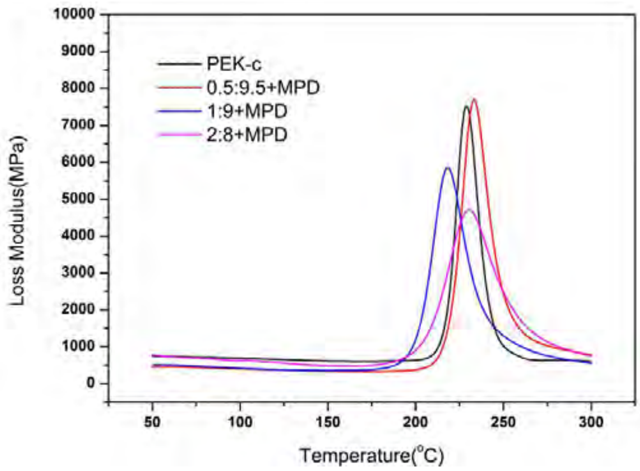

Figure 2. Loss modulus (E'') curves of composites by DMA

The storage modulus of all samples exhibit quite high value (as high as 30000MPa) before the glass transition temperature .With the change of epoxy resin content,Epoxy resin: PEK-c=2:8 showed a higher storage modulus.Epoxy resin to drive PEK-c immersed fiber bundle with the increase content of epoxy resin.However,Analysis of storage modulus and loss modulus,Epoxy resin: PEK-c=0.5:9.5 has the best performance,storage modulus exhibit high value (as high as 42000MPa).According to the relevant literature reports,the storage modulus is closely correlated with the elastic modulus measured by mechanical tests.Therefore, the prepared laminate has excellent mechanical properties.The glass transition temperature reached 219℃.It close to the glass transition temperature of the pure material.Glass transition temperature depends on the ability of the polymer chain, and the ability of the polymer chain is affected by many factors.In this paper,the epoxy content accounts for 5%of the system.The glass temperature is 5 ℃ higher than that of the PEK-c. Because the epoxy curing will produce entanglement network to hinder the movement of the chain,which that makes the glass transition temperature increased.

Figure 2 shown the loss modulus curves of different proportion reinforced laminates.As shown in Figure 2, the $T_{g(E'')}$ of CF/PEK-c composites moved to higher values and the loss modulus peak values became lower with the increase of epoxy resin content. It is because that high content of epoxy resin had lower viscosity when processing and achieved better impregnation with fibers.

3.2 Study on the degree of resin infiltration and the cross section of samples by scanning electron microscopy(SEM)

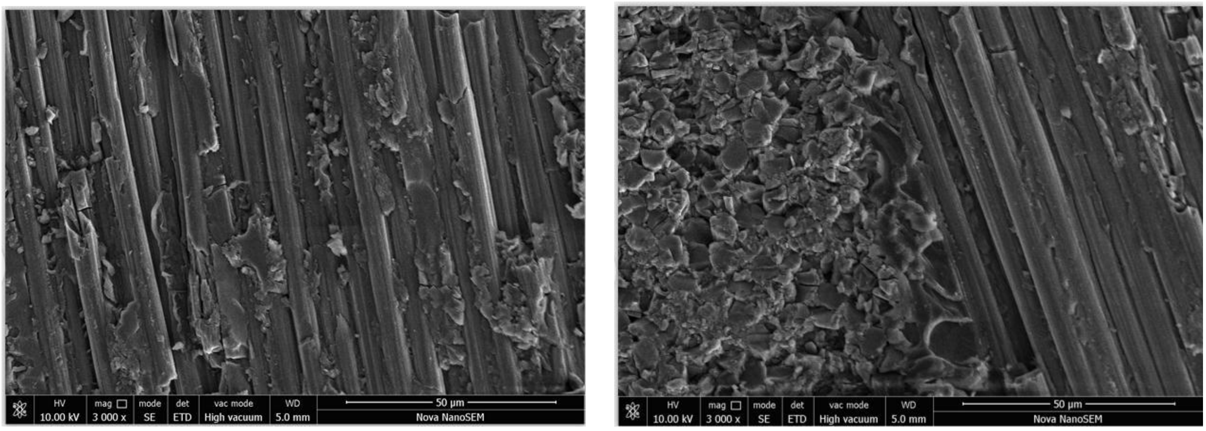

Figure 3.SEM of the cross section of 0.5:9.5composite laminate

The effect of resin matrix can be directly observed from fracture surfaces as shown in Figure 3.The effect of resin matrix can be directly observed from fracture surfaces as shown in Figure 3. Resin is well infiltrated in the fiber bundles shown in Figure3. However, in the process of sample preparation, it will cause different degrees of damage to the fiber bundle. So there are different levels of fiber breakage in Figure 3 .

4. References

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