A new surface treatment method of carbon fiber ---liquid phase-gas phase double effectiveness method (LGDE)

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Introduction

It has been demonstrated by many works that composites of carbon fibers (CF) without any surface treatment have a low interlaminar shear strength (ILSS) [1-3]. It has been shown that ILSS is directly related to the fiber matrix bonding. Oxidative surface treatment improves adhesion between CF and matrix. But the tensile strength of CF is affected by this oxidation method. In this paper, a new kind of surface treatment method of CF, liquid phase coating and gas phase oxidation, was studied.

Experimental

Studies with various HT carbon fibers with different tensile strength were successfully performed. The fiber produced by JiLin had no finish. Pitch was dissolved with tetrahydrofuran (THF) as a coating solution. The fiber was coated with the solution. The thickness of the coating agent on the surface of CF was controlled by the concentration of pitch solution and coating time. The coated CF was oxidated in air at 500 ℃. For the fabrication of UD-composites with 60vol% CF content, a certain concentration acetone solution of AG-80 epoxy resin, produced from Shanghai, China, were used. DDS was used as the hardener. The composites were pressed and cured at 180 ℃ for 2 hours. The tensile strength of treated CF was determined with the test method for tensile properties of CF strands, according to GB3362-82. The interlaminar shear strength of the UD-composites was investigated with the short beam shear test method, according to GB3357-82.

The new surface treatment method, liquid phase coating and gas phase oxidation, is called LGDE method because of it's double effective improvement on the tensile strength of CF and the ILSS of the UD-composites.

Results and Discussion

Fig.1 shows the dependence of tensile strength on the air oxidation time. After coating and air oxidating, a maximum tensile strength is obtained at air oxidation time of 130s. For the certain concentration of coating agent solution, the tensile strength of coated PAN-CF oxidated at different time from 10s to 200s are increased by 4~40%. These effectiveness are achieved by means of improvement of PAN-CF surface flaws, which effect largely upon the tensile strength of PAN-CF.

For PAN-CF with different tensile strength, this method has different effectiveness. The results are shown in Fig.2. The lower the tensile strength of PAN-CF, the more effectiveness this method is. After surface treatment of PAN-CF with tensile strength 2279 MPa, it is increased by 33.60%. But for PAN-CF with tensile strength 3560MPa, the improvement effectiveness is only 8.35%.

The ILSS values shown in Fig.3. The ILSS of the composites produced from untreated PAN-CF is only 60~70MPa. After coating, on the contrary. the ILSS is decreased . It is caused by the relatively weak adhesion among coating agent 、 CF surface and matrix resin. The stresses can't be transferred successfully from matrix resin to reinforcing CF at the interface. But the air oxidation treatment improves adhesion between coating and CF surface, and modifies the surface characteristic of coated CF . The ILSS of the composites produced from treated PAN-CF is increased to 90~110MPa. And the shear fracture toughness of the composites is improved.

Conclusion

The studies have shown a remarkable development potential of the new surface treatment method of CF. The surface treatment method (LGDE) have double effectiveness to, the tensile strength of treated PAN-CF and the ILSS of the composites. The improvement is attributed largely to combination of liquid phase coating and gas phase oxidation, the former improves CF surface flaws and protects from excessively oxidative etching, the latter improves the surface characteristic of CF.

References

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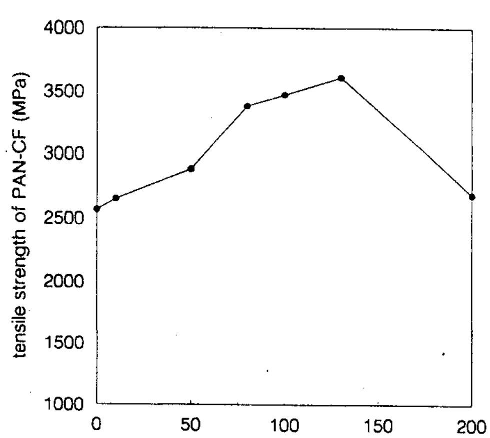

Fig.1 The effect of air oxidation time on tensile strength of coated PAN-CF

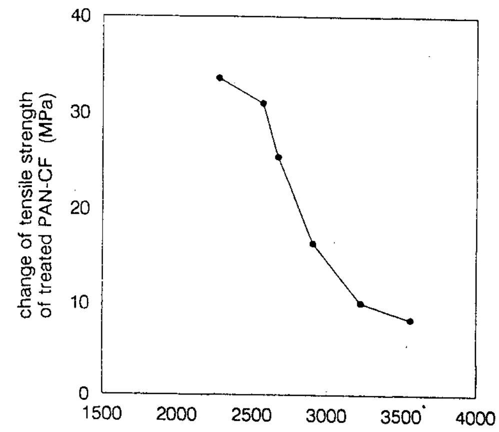

Fig.2 The comparison of effectiness untreated PAN-CF with different tensile strength

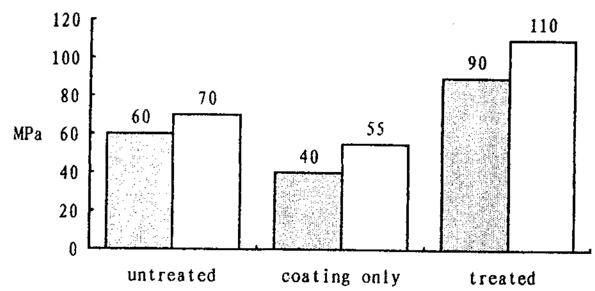

Fig.3 The values of ILSS of CFRP made from untreated ,coated only and treated PAN-CF