

POLYSILOXANE CARBON FIBRE COATINGS FOR THE PRODUCTION OF CARBON FIBRE REINFORCED CARBONS WITH PHENOLIC RESIN AS MATRIX PRECURSOR

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INTRODUCTION

Carbon fibres are mainly used in the reinforcement of epoxy resins; thus surface oxidation and sizing of the fibres should be optimized in view of this application. The problem of fibre sizings in the production of CFC obviously is not discussed in the open literature. It should be a major problem in the production of CFC from HT carbon fibres and phenolic resin as matrix precursor. Without an appropriate fibre sizing or coating, the adhesion of the phenolic resin matrix to the carbon fibre surface may be such strong that both the matrix and the fibres are damaged by the strong resin shrinkage during curing and carbonization of the composite [1]. In this paper the effect of extremely thin polysiloxane coatings for blocking of active sites at the surface oxidized carbon fibre was studied.

EXPERIMENTAL

Studies with various HT carbon fibres were successfully performed [2], results with the Tenax HTA fibre, produced by AKZO, will be presented as an example. The fibre has been surface oxidized by the producer, but had no finish. Polydimethylsiloxane and polymethylphenylsiloxane, procured from Sigma Chemie, Germany, were used as coating agents. Both polymers have a room temperature viscosity of $12.5 \cdot 10^{-3} \text{ m}^2/\text{s}$. For coating of the fibres strongly diluted solutions of the polysiloxanes in dichloromethane were used; the coatings were cured in humid air at 360°C (curing time 30 min). For the fabrication of UD composites with 60 vol% fibre content the fibres were infiltrated with a solution of the phenolic resin RP 226 from Bakelite, Germany, in dry methanol. The composites were pressed and cured at 180°C , heated with 0.2 K/min to 1000°C for carbonization and with 0.5 K/min to 2100°C for graphitization treatment. The flexural strength of the cured, carbonized and graphitization treated composites were determined with the 3 point bending test, according to DIN 53452 [3]. The shear failure of the

composites was investigated with the short beam shear test according to ANSI /ASTM D 2344-84 [4].

RESULTS

Figs. 1 (a) to (c) show the flexural strengths of the cured, carbonized, and graphitization treated composites in dependence of the polydimethylsiloxane (PDMS) concentration of the coating solution and coating time. The results obtained with unsized and commercially sized fibres are given for comparison (∇ , Δ). After curing, a maximum flexural strength is obtained with the most diluted PDMS solution of 0.05 % at a coating time of 30 s (Fig. 1 (a)). For the more concentrated PDMS solutions, maxima of the flexural strength are found at lower coating times, but the maximum values do not reach that found with the 0.05 % PDMS solution. After carbonization and graphitization treatment, maximum flexural strength values are found again with the most diluted solution and the same coating time. The flexural strength after carbonization is increased from about 200 MPa (unsized and commercially sized fibre) to 400 MPa, and after graphitization treatment from about 450 MPa (unsized and commercially sized fibre) to 800 MPa. These improvements were achieved with less than a monolayer of the polysiloxanes [2].

The interlaminar shear strength values are shown in Figs. 2 (a) to (c). After curing the interlaminar shear strength values of the composites are decreased by increasing thickness of the coating (increasing concentration and coating time). This weakening of the fibre-matrix-interface is aimed for diminishing stresses, which can be induced by the resin shrinkage during curing and pyrolysis/carbonization. After carbonization and graphitization treatment the interlaminar shear strength of the samples with the maximum flexural strength is increased; this should be a consequence of the polysiloxane conversion to silica or SiC. Very similar results and identical maximum flexural strengths after the various treatment steps of the composites were found with polymethylphen-

ylsiloxane coatings [2] and phenolic resin coatings [5].

CONCLUSION

The studies have shown a remarkable development potential of CFC from HT carbon fibres and phenolic resin by optimization of the phenolic resin adhesion to the carbon fibre surface with an appropriate coating. Further improvements are expected by application of a high quality phenolic resin.

ACKNOWLEDGEMENT

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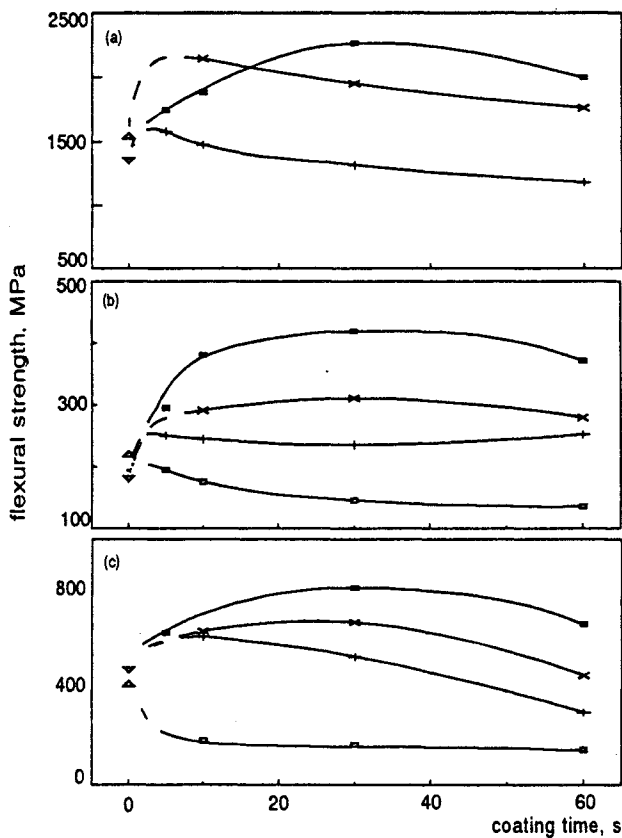


Fig. 1: Flexural strength of cured (a), carbonized (b), and graphitization treated (c) composites in dependence of time used for coating of the fibres with different solutions of polydimethylsiloxane (PDMS).
 ▽ non-coated, Δ commercially coated, ■ 0.05% PDMS, × 0.1% PDMS, + 0.2% PDMS, □ 1% PDMS.

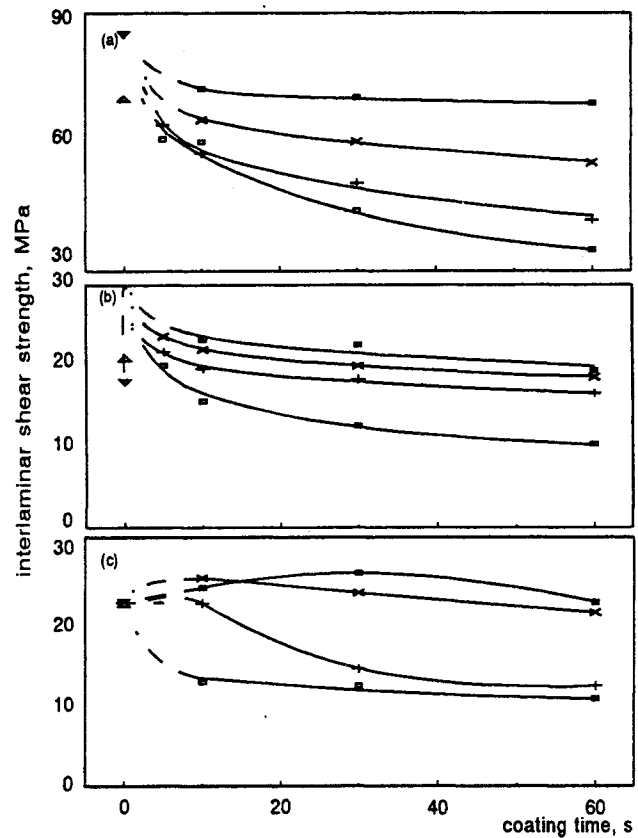


Fig. 2: Interlaminar shear strength of cured (a), carbonized (b), and graphitization treated (c) composites in dependence of time used for coating of the fibres with different solutions of polydimethylsiloxane (PDMS).
 ▽ non-coated, Δ commercially coated, ■ 0.05% PDMS, × 0.1% PDMS, + 0.2% PDMS, □ 1% PDMS.