CARBON FIBRES FROM SUCCINIC ACID MODIFIED PAN PRECURSOR

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INTRODUCTION

Post spinning modification of PAN fibres using organic acids as plasticizers has been found to be effective in deriving low diameter and high performance carbon fibres (1-3). However, these modification methods had certain limitations (2,3) because of the size of the organic molecules and their reactivity. To overcome these drawbacks a new plasticizer, namely succinic acid has been tried in the present study and its influence on the mechanical properties of the resulting carbon and graphite fibres is discussed.

EXPERIMENTAL

Courtelle, PAN precursor fibre, 12K, 1.2 d'tex was treated with aqueous soln. of succinic acid at 100°C (sample M). However, treated sample was not washed with water because no weight uptake of succinic acid was observed after washing. This suggests that succinic acid does not react with PAN chemically but only remains physically adhered to the fibre surface.

Untreated (P) as well as Modified (M) samples were thermally stabilized at 250°C in air and were then carbonized to 1300°C and 2500°C under identical conditions.

RESULTS AND DISCUSSION

As shown in table 1, the chemical treatment does not effect the mechanical properties of the precursor PAN fibre. This confirms that the succinic acid as such does not react with the fibre structure.

Fig.1 shows elongation behaviour of the two samples during thermal stabilization step. Sample M shows overall stretching of 30% which is three times more than what is possible for sample `P' (9%).

As observed earlier, succinic acid itself does not attack the structure of PAN. However, during thermal stabilization at temperatures >130° C, succinic acid present on the fibre surface gets converted into the succinic anhydride [fig.2 (1)]. This is confirmed by the higher weight loss (3%) in the temperature range 100-200°C in the sample M as against the unmodified sample P (1.6%). Because of the availability of lone pair of electrons, succinic anhydride attacks the carbon present in the nitrile group in PAN [fig.2 (2)]. Such interactions amongst the two imparts plasticizing effect to the molecular chains, which results into higher elongation during thermal stabilization, as observed for fibres M.

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Interestingly, higher elongation in sample M is only possible when no air flow is allowed during thermal treatment. This suggests that presence of succinic anhydride vapors around the fibre is essential for its plasticizing effect.

As seen from table 1 the succinic acid modification has definite effect on the diameter of the carbon fibres (HTT 1300°C) which is reduced to 6.20 μ, about a micron less than the diameter of the carbon fibres prepared from unmodified fibre (PC) (7.18μ). As a result, the tensile strength of fibre MC (2823MPa) shows an increase of 35% over PC carbon fibre (2103 MPa).

As seen in the last column of table-1, the effect of modification is more pronounced in the Young`s modulus of sample MC2500, which is almost 50% higher for some of the samples (600 GPa) as compared to 400 GPa for PC2500.

ACKNOWLEDGEMENT

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TABLE 1

Mechanical properties of the unmodified and modified PAN fibres and resulting carbon fibres

Treatment	fibre type	Dia μ	T.S MPa	(cov) %	Y.M GPa
Unmodified (P)	Precursor	12.57	522	(11)	6.5
	•Carbonized(PC)	7.18	2103	(18)	221
	••Graphatized (PC2500)	6.43	1936	(22)	401
Modified with succinic acid (M)	Precursor	12.57	495	(12)	6.3
	•Carbonized(MC)	6.20	2823	(16)	210
	••Graphatized (MC2500)	5.86	2556	(19)	500-600

•HTT 1300 C ••HTT 2500 cov- coff. of variation

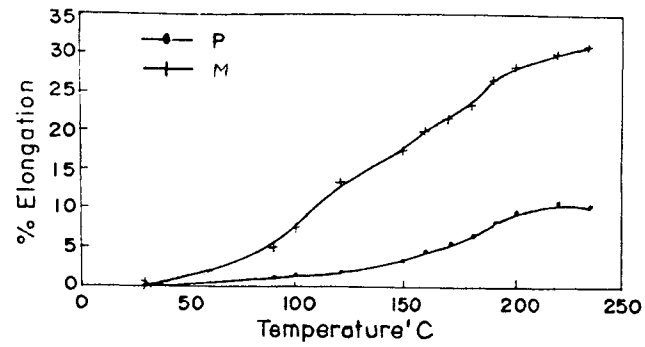

Fig.1. Elongation behaviour of different fibres.

(P) Precursor (M) Succinic acid treated

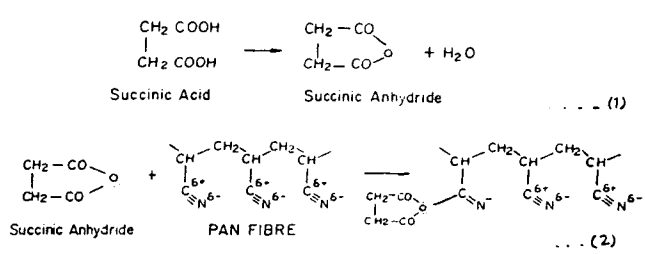

Fig 2 .Proposed Reaction Mechanism of Succinic Acid treatment of PAN Fibres
(1) Conversion of Succinic Acid to Succinic Anhydride
(2) Reaction of Succinic Anhydride with PAN FIBRE.