FILAMENTS FROM BLENDS OF DIFFERENT MOLECULAR WEIGHTS OF POLYPROPYLENE AND CARBON NANOFIBRES

by

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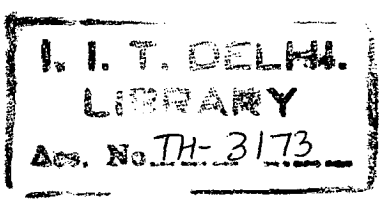
Polypropylene fibers



CERTIFICATE

This is to certify that the thesis entitled **"FILAMENTS FROM BLENDS OF DIFFERENT MOLECULAR WEIGHTS OF POLYPROPYLENE AND CARBON NANOFIBRES"** being submitted by **Mr. Arobindo Chatterjee**, to the Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy** in the Department of Textile Technology, is a record of bonafide research work carried out by him. Mr. Chatterjee has worked under my guidance and supervision and fulfilled the requirements for the submission of the thesis.

The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

An approach for production of high modulus polypropylene filament is developed. Blends of 35 MFI and 3 MFI PP resins are used as feed material. The blended chips are melt spun, drawn on a conventional two stage drawing at 60°C and 110°C and further drawn on a "Gradient Drawing"® system. All the steps in the process are continuous in nature.

Blending modifies the morphology of the blend filament making it more amorphous and comparatively easy to deform. Selection of samples is based on comparatively high sonic modulus values of the drawn filament. For 35/3(90:10) blend, a final draw ratio of 16.6x can be achieved using a gradient drawing temperature profile of (150-150-160)°C. The blend filament exhibits a sonic modulus of 28.5 GPa.

The process of blending and ultradrawing on a heater leads to very high x-ray crystallinity of 74%, crystalline and amorphous orientation functions of 0.99 and 0.88 respectively. DSC studies indicate presence of narrow crystal size distribution and high degree of crystal perfection. A very shallow and broad β-transition and high storage modulus of 20 GPa at -70°C indicate the presence of highly oriented amorphous phase. Initial modulus of 16.4 GPa, tenacity of 667 MPa and elongation of 4.5% are obtained.

In an attempt to further enhance the modulus of the filament carbon nanofibres are incorporated in the PP blend. Further enhancement of draw ratio to 19.3 can be

achieved for the nanocomposite filament. Improvement in property in terms of modulus of 16.8 GPa, tenacity of 770 MPa and elongation of 7% are obtained at 1% loading of carbon nanofibres. The nanocomposite filament exhibits a prominent β-transition at ~25°C and a storage modulus of 29 GPa at -70°C. A comparatively low degree of x-ray crystallinity of 61% is also observed. DSC study of nanocomposite filament indicates that the carbon nanofibres act as nucleating agents and hinder growth of PP crystals. The resultant effect is a increased crystallisation rate.

Based on the above observations, it is reasonable to propose that PP molecules around carbon nanofibre are in a highly oriented and amorphous state. A morphological model for the nanocomposite filament is also proposed.

Influence of carbon nanofibres on the thermal stability of PP has been analysed. Significant improvement in oxidation induction time and thermal stability has been observed. The burning behaviour is also influenced.

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