STUDIES ON RADIATION-INDUCED GRAFT COPOLYMERIZATION OF METHACRYLIC ACID ONTO POLYPROPYLENE FIBERS

By

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DEPARTMENT OF TEXTILE TECHNOLOGY

Submitted

in fulfilment of the requirements of the degree of

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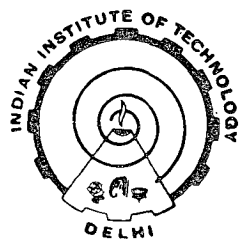

to the

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

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DEDICATED

TO

MY BELOVED PARENTS

CERTIFICATE

This is to certify that the thesis entitled "Studies on Radiation-Induced Graft Copolymerization of Methacrylic Acid onto Polypropylene Fibers" being submitted by Mr. B.D. Gupta to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy in Textile Technology, is a record of bonafide research work carried out by him. Mr. Gupta has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to my knowledge, has reached the requisite standard.

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

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ABSTRACT

The present investigation deals with the graft copolymerization of methacrylic acid onto polypropylene (PP) fibers, followed by their characterization and evaluation of properties. The grafting was carried out by simultaneous-irradiation technique using a Co^{60} gamma-ray unit and the effects of various parameters on grafting, such as total dose, dose rate, monomer concentration, and liquor ratio in different solvent media, were studied. The grafting was observed to be affected by the nature of the solvent.

The presence of polymethacrylic acid (PMAA) grafts onto the PP fiber was ascertained by infrared spectroscopy and TGA results of PP, grafted PP, and a blend of the same amount of PP and PMAA present in grafted samples. The grafted fibers were characterized by X-ray diffraction, diameter, and density measurements. The crystallinity changes in the grafted fibers, as evaluated from X-ray diffraction studies, did not reveal any change in the inherent crystallinity of the polymer by grafting, thus indicating that grafting has taken place mostly in free amorphous regions.

Thermal behavior of grafted fibers has been evaluated by thermogeavimetric analysis (TGA), differential scanning calorimetry (DSC), and flammability studies. Thermal decomposition of the grafted samples was expressed in terms of initial decomposition temperature (IDT), integral procedural decomposition temperature (IPDT), and T_{50}, a temperature at which 50% decomposition of the sample takes place. The thermal stability of polypropylene fibers was observed to improve remarkably by the grafting of methacrylic acid. This may be ascribed to the cyclization of PMAA chains, thus producing a more stable structure. The influence of grafted PMAA content upon melting and crystallization behavior of the backbone polymer was also evaluated. The inherent crystallinity of the backbone polymer i.e., polypropylene, in the grafted samples as evaluated by DSC, did not show any change over the whole range of graft levels and were observed to follow a trend similar to that found by X-ray studies.

Flammability characteristics, as expressed by LOI of polypropylene fiber, did not show any marked increase with the increase in the PMAA content in the samples. The mechanical properties of PP-g-PMAA fibers were measured using 'Instron' tensile tester and in general, an improvement in the tensile properties, such as in tenacity, elongation,

initial modulus, and denier over that of ungrafted fiber was observed. The moisture regain of the fibers showed a remarkable increase with the increasing graft content and has been ascribed to the increase in the hydrophilicity of fibers by the incorporation of polar carboxyl groups.

The dyeing behavior of the fibers was evaluated using two basic dyes viz., Rhodamine B and Methylene Blue. The dyeing was carried out at 100°C using different time intervals from 15 min to 16 hr under infinite dye-bath concentration. The dye-uptake of polypropylene fibers showed a considerable improvement with the increase in percent graft in the fibers. However, dye-uptake with Methylene Blue was higher than Rhodamine B. The diffusion coefficient and rate of dyeing showed a sharp increase in the grafted fibers over that of ungrafted fiber. Such a behavior has been attributed to the change in the fiber structure by grafting.

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