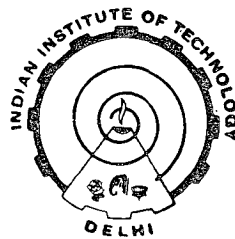


**STUDIES ON RADIATION-INDUCED GRAFT  
COPOLYMERIZATION OF METHACRYLIC ACID  
ONTO POLYPROPYLENE FIBERS**

By  
B. D. GUPTA  
DEPARTMENT OF TEXTILE TECHNOLOGY

Submitted  
in fulfilment of the requirements of the degree of  
**DOCTOR OF PHILOSOPHY**



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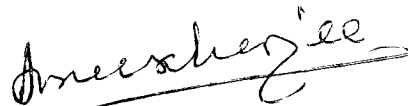
**INDIAN INSTITUTE OF TECHNOLOGY, DELHI  
MAY 1984**

**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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## ACKNOWLEDGEMENTS

I am deeply indebted to extend my deep sense of gratitude to Dr. A.K. Mukherjee, Assistant Professor, Department of Textile Technology, for his esteem and effective guidance and consistent encouragement during the course of this investigation.

I am thankful to Prof. (Miss) P. Bajaj, Head of Textile Technology Department, for providing all possible facilities to carry out the research work.

I am highly grateful to Dr. Harpal Singh, Centre for Biomedical Engineering, for his continuous interest and timely suggestions on various aspects, throughout the period of my research work.

My sincere thanks go to Dr. A.K. Gupta and Mr. Samir Sanyal for useful discussion with them.

My thanks also go to my brother Mr. S.P. Gupta and many of my colleagues, Mr. R.K. Soni, P.K. Sharma, M.R. Patri, and S.N. Purwar for their valuable assistance.

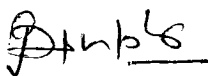
A special word of appreciation is for Dr. Y.S. Negi, Department of Textile and Polymeric Materials, Tokyo Institute of Technology, Tokyo (Japan), for togetherness and valuable help, throughout his stay at I.I.T. Delhi.

I would like to thank Mr. A.C. Alexander for his valuable help rendered to me in carrying out the irradiation experiments in the School of Life Sciences, Jawahar Lal Nehru University, New Delhi.

Indian Petrochemicals Corporation Ltd., Gujarat is gratefully acknowledged for providing the gift samples of polypropylene.

My thanks also go to Mr. Rajesh K. Arora for neat and accurate typing and Mr. K.G. Padam for tracing the figures.

Finally, I feel deeply indebted to all my family members for whom this undertaking has resulted in many hours when I was unavailable for tasks more important and pleasant to them.

  
(B.D. GUPTA)

## 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 thermogravimetric 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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