Journal of Macromolecular Science, Part A
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597274

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To cite this Article Mohanty, N. , Das, H. K. , Mohanty, P. and Mohanty, E.(1995) 'Modification of Muga Silk by Methyl-Methacrylate. II', Journal of Macromolecular Science, Part A, 32: 1, 1103 — 1111
To link to this Article: DOI: 10.1080/10601329508019151
URL: http://dx.doi.org/10.1080/10601329508019151

MACROMOLECULAR REPORTS, A32(SUPPL. 7), 1103-1111 (1995)

MODIFICATION OF MUGA SILK BY METHYL-METHACRYLATE. II

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SUMMARY

The physical properties of Methyl Methacrylate grafted Muga silk fiber (9.05 to 25.5% graft) were studied using standard methods. Properties of textile interest such as thermal insulating capacity, tensile properties like breaking load, tenacity, tensile strength, young's modulus, and electrical properties such as electrical resistance were found to decrease with an increase in percentage of grafting. Possible explanations for such changes in properties are advanced and suitable end uses for the grafted fiber identified.

INTRODUCTION

Muga Silk is an excellent textile fiber and is produced in many parts of Asia. It is different from and superior to cultivated mulberry silk in many respects. Compared to mulberry silk Muga Silk contains more alanine than glycine, greater amount of dicarboxylic acid and diaminoacids and also is more resistant to oxidizing agents than mulberry silk (1). Muga Silk is scarcely affected by various salt solutions such as alkaline solutions of copper hydrate in glycerol, $ZnCl_2$, $CaCl_2$, $LiCl_2$ and $MgCl_2$ whereas ordinary silk is readily soluble in these reagents(2).

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Due to its gloss, dyeability, eye appeal and drape characteristics, Muga Silk is the fabric of choice for ceremonial use, It is also an excellent material for embroidery, To improve the textile properties of silk, blending with other synthetic fibres has been attempted (3). However, the chemical modification of Muga Silk has not been investigated much. In a previous communication some other physical properties of Muga Silk showing an increasing trend with grafting have been reported (4). This communication presents a few other textile properties of Muga Silk which shows decreasing trends with grafting.

The observed increase in thermal insulating capacity but decrease in electrical resistance of grafted Muga fiber suggests its end use as furnishing fabrics, as fabric insulator, as draperies, and in automotive applications, The decrease in electrical resistance of the fiber with grafting implies a built up of a small amount of static charges on the fiber surface and that makes the fiber more suitable for processing with textile machinery.

EXPERIMENTAL

Muga silk fibers were collected from Assam Spun Silk Mills Ltd., Jagi Road, Assam, India. They were degummed by the method of Mohanty et al. (5). Then the fibers were grafted with methyl methacrylate in an aqueous solution of Ce(IV) (0.005 to 0.05M) at 50°C for 1 to 8 hrs using known methods (5,6). The rate of grafting and % grafting were controlled by controlling the initiator concentration, temperature of reaction and monomer concentration. The % grafting of grafted fibre was found to increase with increasing initiator concentration upto 0.0175 m/l. The same also increased with increase in monomer concentration upto 0.469 m/l. It increased on raising the reaction temperature from 32°C to 50°C. The grafting percentages were calculated following the methods of Kojima et. al.(7). The grafted fibers were Soxhlet extracted with acetone until completely free from homopolymers and then oven dried at 60°C for 6 hrs followed by cooling to room temperature. The grafted silks of different percentage values so prepared were characterised as follows : Infrared spectra of the grafted samples were recorded by Pressed-Disc Technique on Shimadzu, Japan, IR-408 model Infrared spectrophotometer. Shimadzu DT-30 thermobalance was used to record the Thermogravimetric Analysis and Differential Thermal Analysis Curves in an atmosphere of static air from room temperature to 800°C. The samples were characterized by studying their alkali solubility in 0.1N sodium hydroxide solution at 65°C by using the method of Leaveau et.al.(8)

9.05%, 11.25%, 15.18% and 25.50% grafted fibres were used to study their physical properties.

RESULTS AND DISCUSSION

Thermal Conductivity

Thermal Conductivity (K) of ungrafted and grafted Muga fibres was studied by using the disk method (9). The thermal insulating capacity of the fibre (K^{-1}) is given by the expression :

$$K^{-1} = \frac{A\,(t_1 - t_2)}{msd\,(d\theta/dt)_{t_2}}\ Cal^{-1}.\ Sec.\ cm\ degree$$

Where,
m = Mass of the disk
s = Specific heat of the material of the disk.
d = Thickness of the sample
$(d\theta/dt)_{t_2}$ = Average rate of cooling of the disk.
A = Area of the sample
t_1-t_2 = Temperature difference in °C. (10,11)

The results of thermal insulating capacity (K^{-1}) measurements are presented in Fig.1. It is noticed that the thermal insulating Capacity (K^{-1}) increases as percentage of grafting increases. Since K^{-1} depends on the nature of the fibre as well as on the size and number of air spaces present in it, the increase of K^{-1} value with grafting can be explained as due to increased porosity of the grafted fiber as noted earlier by the authors. (4)

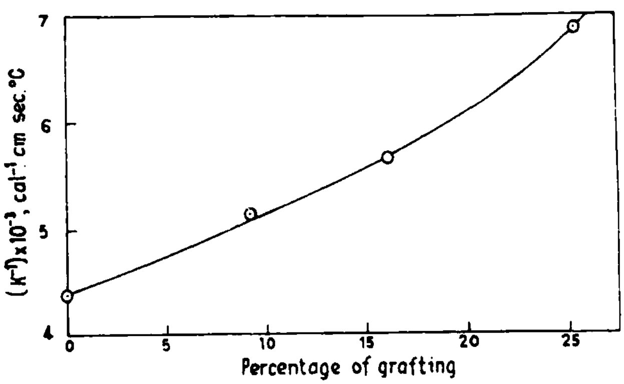

Fig.1 Variation of thermal insulating capacity with percentage of grafting Muga Silk.

Tensile Properties

The tensile properties (12) of both grafted and ungrafted fibers were measured by using an Instron Tensile Tester at 35°C & Constant relative humidity (65%) by the method of Hindiman et. al. (13).

The results of breaking load measurements are shown in Fig.2. It is seen that the breaking load is maximum for the ungrafted fiber but gradually decreases with grafting.

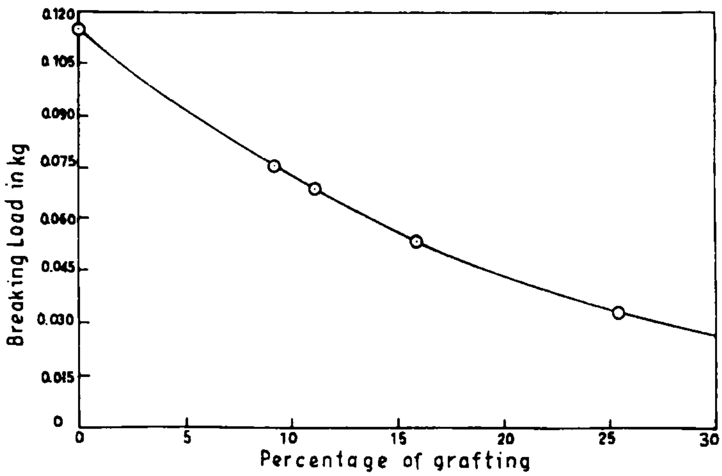

Fig.2 Variation of breaking load with percentage of grafting in Muga Silk.

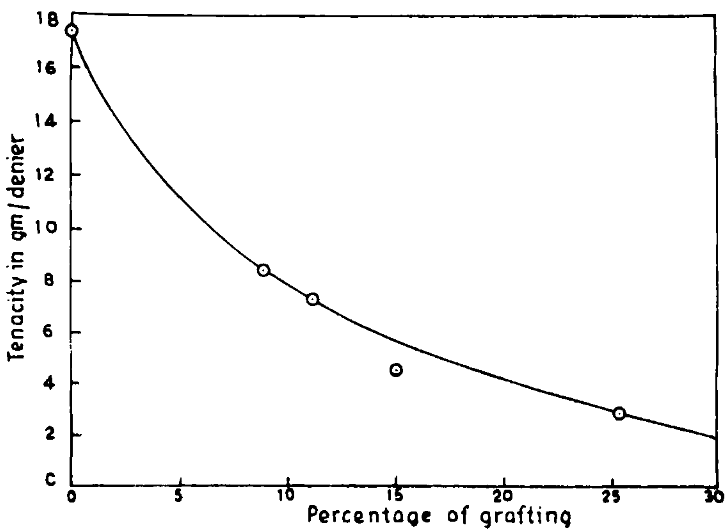

Fig.3 Variation of tenacity with percentage of grafting in Muga Silk.

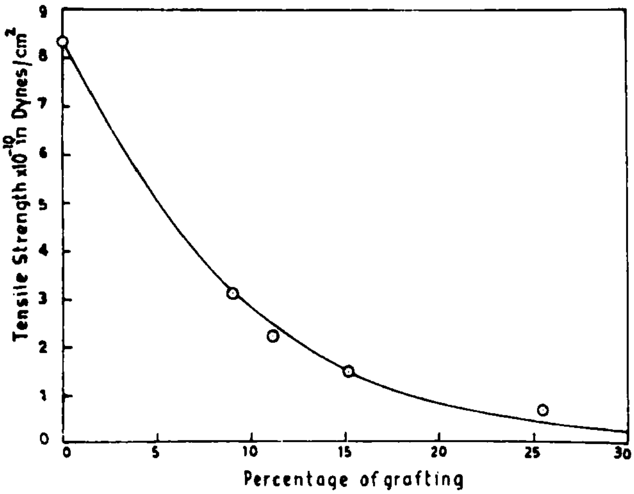

Fig.4(a) Variation of tensile strength with percentage of grafting in Muga Silk.

The results of tenacity measurements are shown in Fig.3. It is observed that the tenacity of the fiber also decreases with grafting.

The results of tensile strength measurements of ungrafted and grafted fibers vs. Percentage of grafting and moisture regain are shown in Figs. 4a and 4b, respectively. It is observed that the tensile strength of the grafted fibers decreases with a rise of grafting percentage, (Fig.4a). In a previous communication (4) we noted that grafted Muga fiber exhibits increasing moisture regain with grafting. As increasing moisture regain of animal fiber is associated with a decrease of tensile strength (14), the fall in tensile strength of the Muga fiber with grafting is reconciled.

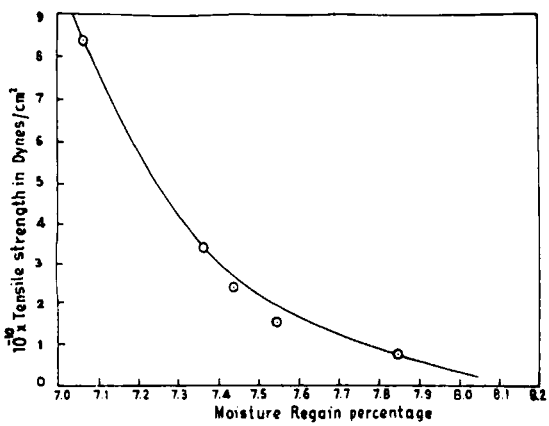

Fig.4(b) Variation of tensile strength with moisture regain(%) in Muga Silk

The values of Young's modulus (y) vs. grafting percentage are shown in Fig.5a. It is noticed that Young's modulus of grafted fiber decreases with a rise in grafting percentage. The variations

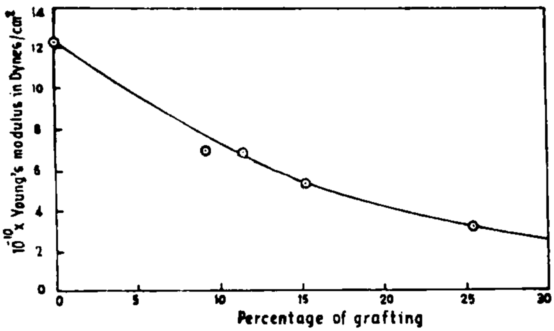

Fig.5(a) Variation of Young's modulus(Y) with percentage of grafting in Muga Silk.

of load with elongation for ungrafted and grafted fibers are shown in Fig.5b. The values of yield point, total stretch, elasticity and elastic limit etc. were calculated from plots of load vs. elongation (Fig.5b.) and are presented in Table 1.

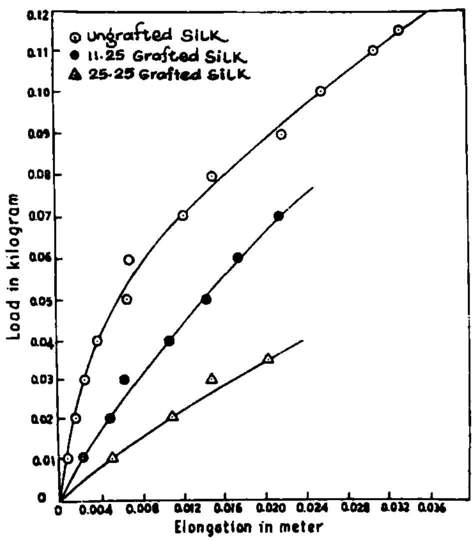

Fig.5(b) Variation of elongation with load in Muga Silk.

TABLE-1

Tensile Properties	Ungrafted	Grafted (11.25%)	Grafted (25.50%)
Yield Point, g/den	0.0500	0.0220	0.0085
Total stretch, cm	0.0340	0.0220	0.0204
Elasticity, cm	0.0060	0.0052	0.0045
Elastic limit, g/den	0.0440	0.0205	0.0060

TABLE-2
Observed and Calculated Electrical Resistance of Muga Fibers.

Nature of the fiber	Moisture content(%)	Resistance by Million Meg-ohmmeter(MΩ)	Resistance cal-culated from empirical formula (MΩ)
Ungrafted	6.612	6.615×10^9	7.502×10^9
Grafted (9.05%)	6.851	3.802×10^9	4.238×10^9
Grafted (11.25%)	6.932	3.208×10^9	3.526×10^9
Grafted (15.18%)	7.031	2.233×10^9	2.559×10^9
Grafted (25.50%)	7.279	1.156×10^9	1.614×10^9

The general decrease of tensile properties with grafting may be explained by supposing a marked relaxation of the intermolecular hydrogen bonds, formed between the amide and hydroxyl groups of the silk material, during grafting causing easy diffusion of water molecules into the internal surface of the fiber (15,16). This explanation is analogous to that advanced by Brown and workers (14). Possibly, the loss of crystallinity of the fiber and oxidative degradation of the backbone of the silk protein during grafting may be the other contributory factor to this decreasing trend.

Electrical Property

The electrical resistance of ungrafted and grafted fibers were determined with the help of a Million Megohmmeter (BPL, Model RM 160 Mk IIIA) and was also calculated by using the corrected empirical formula (17) :

$$R = aM^{-n}$$

Where R = resistance in megohms of a 4-cm length fiber.
M = Moisture content
a and n are constants.

For silk,

a = 23, n = 16.

The experimental and calculated results for ungrafted and grafted fibers are shown in Fig.6. (Table 2)

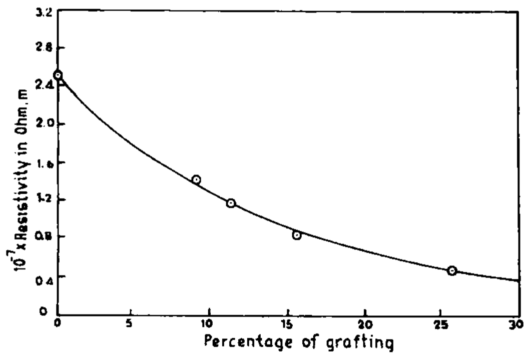

Fig.5 Variation of electrical resistivity with % of grafting in Muga Silk.

The grafted fibers were found to have reduced electrical resistance compared to the ungrafted one. We have noted (4) before that with an increased percentage of grafting, there is a rise in moisture content, which implies incorporation of more water molecules in the pores of the fiber surface. Hence, the decrease in grafting percentage is reconciled with reduced electrical resistance, and is explained as due to the formation of a continuous conducting film of moisture over the internal and external surfaces of the fiber (18).

Other physical properties of the fibre showing opposite trend are under report in a separate communication.

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