

# AN ULTRAVIOLET GRAFTING TECHNIQUE FOR COTTON FABRIC FINISHES

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## Abstract

Graft polymerization of finishing polymers onto cotton substrates is a potential route by which the problem of durability of flame retardant textile finishes could be overcome. This work reports initial results in the development of a method for grafting polymers to cotton fabric by ultraviolet radiation. Photolytic grafting is limited by the depth of ultraviolet penetration into the substrate and, in this application, ideally results in the polymer chains of the finish being on the surface of the textile. Photosensitized print cloth was grafted with poly (methyl methacrylate) as the finishing polymer. Grafting onto the textile surface has been confirmed by solid-state nuclear magnetic resonance spectroscopy and attenuated total reflectance infrared spectroscopy. Standard strength tests on the print cloth indicate that a moderate loss in tear strength results from the loss of molecular weight due to the photosensitizing treatment, but this loss in strength is overcome by the grafting/finishing reaction due to entanglement of the polymer chains on the surface of the cloth.

## Introduction

One of the limiting factors of flame retardant finishes is durability of the finish to wear and laundering (Vigo 1973). Finishes that are not durable to laundering render cotton products unsuitable for everyday applications, limiting the markets for which the products are available. Graft polymerization of finishing polymers onto cotton textile is being investigated as a route to overcome this problem. A graft copolymer consists of a backbone polymer with one or more branches, or grafts, covalently bonded to the backbone polymer chain. Several techniques are available for the synthesis of such grafted structures. One method of grafting polymer chains onto a substrate is by ultraviolet radiation in combination with a photosensitizer. Previous work by Margutti et al demonstrated the effectiveness of graft polymerization onto a cellulose substrate (Margutti 2002). Methacrylate and acrylate polymers were grafted onto photosensitized filter paper with good grafting yields. These reactions are fast and efficient, demonstrating promise for application to other cellulose substrates like cotton textiles.

## Materials and Methods

All chemicals were purchased from Aldrich Chemical Company and used after standard purification and/or activation procedures. The cellulose grafting reaction was performed by a modification of the methods outlined by Margutti et al. Cotton print cloth was oxidized with sodium metaperiodate solution in varying concentrations, [0.01], [0.03], and [0.1]. Samples were washed to remove the oxidizing agent and dried. The dried cloth was irradiated in an ultraviolet chamber for 30 min. Methyl methacrylate, in amounts of up to 10% of the weight of the textile sample, was applied to the fabrics manually and the treated cloth was exposed to UV light for 1 h. Non-reacted monomer was removed by washing the fabric in methanol/water (30/70 vol.). PMMA homopolymer was extracted from the cloth surface by washing with acetone. PMMA/cellulose grafting at the substrate surface was confirmed by attenuated total reflectance infrared spectroscopy and solid-state nuclear magnetic resonance spectroscopy. Tensile strength and elongation were determined according to ASTM D 5035 "Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)."

## Results

Print cloth was photosensitized with an oxidizing agent to allow the formation of radical site on the cellulose chains. The dormant macro-radicals are regenerable upon exposure to ultraviolet light. Carboxyl and carbonyl groups generated by oxidation of the cloth become active radical sites on the cellulose that initiate polymerization in subsequent ultraviolet grafting reactions. Spectroscopy results confirm surface modification of the cellulose chains and the presence of grafted PMMA. Strength tests indicate an initial loss in textile strength due to chain scission of cellulose during the oxidation process (figures 1 and 2). After the grafting polymerization reaction, strength is recovered in both the warp and fill directions. The overall loss in strength is less than 12%. Initial data sets demonstrate no statistical difference in breaking strength for the control samples and the PMMA/cellulose grafted samples.

## References

T.L. Vigo, A.M. Collins, C.M. Welch, "Flame-retardant cotton fabrics by reaction of cellulose with phosphorus trichloride-DMF adduct," *J. Appl. Polym. Sci.*, **17**, 571 (1973).

Margutti, S., Vicini, S. Proietti, N., Capitani, D., Conio, G., Pedemonte, E., Segre, A.L., "Physical-chemical characterisation of acrylic polymers grafted on cellulose," *Polymer*, **43**, 6183 (2002).

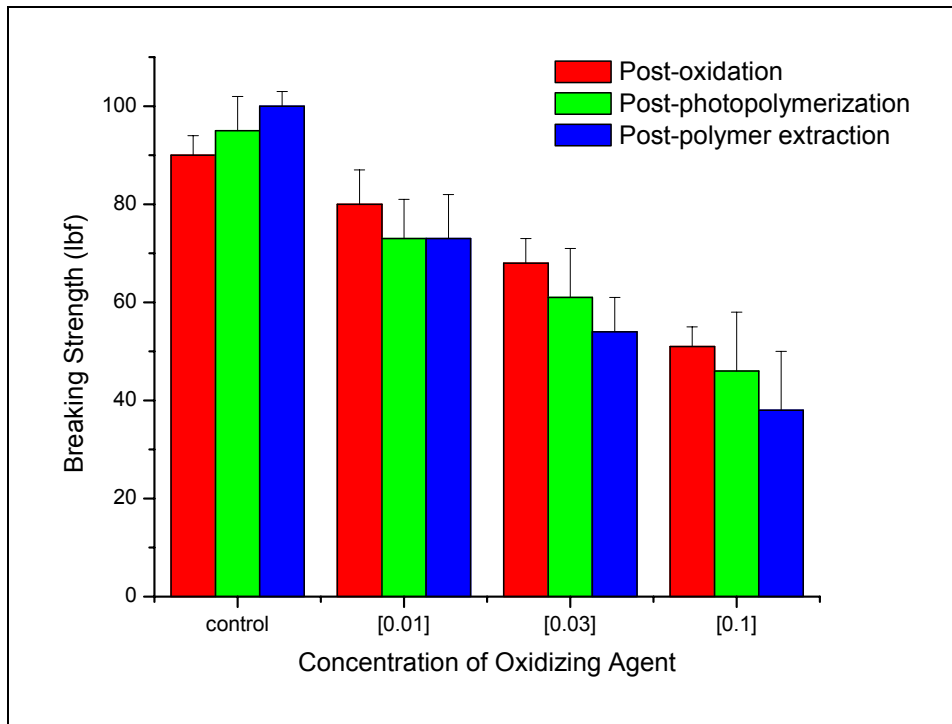


Figure 1. Breaking strength in the fill direction.

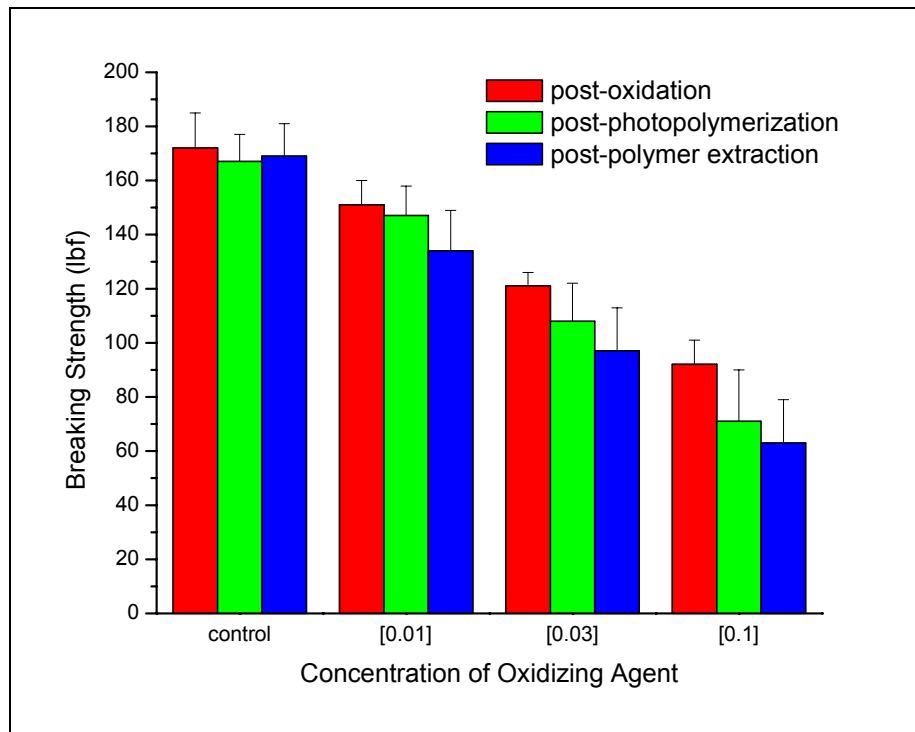


Figure 2. Breaking strength in the warp direction.