Antimicrobial Finish of Silk Fabrics by Chitosan UV-Curing

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PERIOLATTO Monica, *FERRERO Franco*
Politecnico di Torino, Dipartimento di Scienza dei Materiali e Ingegneria Chimica, Turin, Italy
monica.periolatto@polito.it

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Introduction

Silk from *Bombyx mori* is not only one of the most precious fibres used in textile industry but also a biopolymer of great interest, thank to its biocompatibility, if applied in biomedical and biotechnological devices.[1] In this field, the assignment of antimicrobial activity has great importance.[2] However a general problem related to all antimicrobial chemicals is to find the balance between high biocide activity and the requirements of safe handling, including non toxic finish processes, non-toxicity to humans at usual concentrations and environmental demands.

Our idea is the application of chitosan on silk by UV radical curing.

Chitosan, 2-amino-2deoxy-(1→4)-β-D-glucopyranan, is a biopolymer with unique properties such as biodegradability, nontoxicity, antimicrobial activity, derived from the deacetylation of the chitin component of the shells of crustacean. Chitosan is already used in textile field, applied by wet thermal curing involving relatively high temperature with energy consumption, costs and possible fabric degradation; moreover the addition of toxic reagents, such as glutaraldehyde, is requested as crosslinking agent.[3]

In UV curing, however, radical species are generated by the interaction of UV light with a suitable photoinitiator, which induces the curing reaction of reactive monomers and oligomers at low temperature and quickly, with lower environmental impact and lower process cost than thermal process.[4]

There are no specific studies about chitosan UV-curing, but the effects of exposure to UV light of chitosan films or blends, forming macroradicals have been widely studied in the field of UV degradation.[5-6] We supposed the same radicals can be involved in the photolymerization process.[7]

Materials and Methods

Pure silk fabrics were finished with low viscous chitosan (Fluka) radically cured adding Darocure 1173 (Ciba Specialty Chemicals) 2%wt as photoinitiator. Chitosan was diluted in a 2%vol acetic acid solution, under magnetic stirring at ambient temperature for 24h. Then photoinitiator was added, the mixture was diluted with acetic acid solution, spread on the fabrics with various impregnation times, at ambient temperature or 50°C, dried for 10 min at 80°C-100°C and finally UV-cured for 30-60 sec, in inert atmosphere.

The fabrics were irradiated by a medium-pressure mercury lamp with a light intensity on the fabric of about 20mW/cm^2, in a small box equipped with a quartz window under nitrogen atmosphere (oxygen content under 20 ppm).

Results and Discussion

All the treated samples were prepared with a chitosan add-on of about 2%, to maintain silk hand characteristics, obtaining yields of the process close to 100% in all cases.

Antimicrobial activity test was performed according to ASTM E2149-01 method, using Escherichia Coli ATCC 8739 as microbes. Test on treated samples revealed the antimicrobial efficiency, with complete elimination of microorganism; moreover, the same test was carried out on treated fabrics subjected to 5 washing cycles with standard ECE detergent (UNI-EN ISO 105-C01) and the best results in terms of fastness were found with 1h impregnation at 50°C, with 75% microorganism reduction.

The partial loss of antimicrobial activity after washing was due to the loss of chitosan from fibres, as confirmed by dyeing tests with an acid dye to reveal chitosan presence on fabrics.

The surface morphology of treated fabrics was examined by SEM with a Leica (Cambridge, UK) Electron Optics 435 VP scanning electron microscope. Acquired images revealed a good homogeneous distribution of chitosan on the fibres. It is shown that the polymer does not form a coating on the textile but it covers every single fibre without gluing them.

Finally, further characterizations on chitosan films and silk fabrics were performed by DSC and FTIR-ATR analysis, confirming the chitosan polymerization and its presence on fabrics.

Conclusion

In conclusion, from these results, chitosan UV-curing can be indicated as a valid alternative environmental-friendly method to confer antimicrobial activity to silk fabrics. Further studies should increase the treatment fastness, test the material for biomedical applications and deeply investigate the grafting reactions occurring.

References

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