Surface & Coatings Technology 271 (2015) 165–173

Contents lists available at ScienceDirect

Surface & Coatings Technology

journal homepage: www.elsevier.com/locate/surfcoat

Cotton and polyester surface modification by methacrylic silane and fluorinated alkoxysilane via sol–gel and UV-curing coupled process

Monica Periolatto, Franco Ferrero *

Politecnico di Torino - Dipartimento di Scienza Applicata e Tecnologia Corso Duca degli Abruzzi, 24 10129 Torino, Italy

ARTICLE INFO

Available online 27 December 2014

Keywords:
Cotton
Polyester
Sol–gel
UV-curing
Fluorolink® S10
MEMO

ABSTRACT

The aim of the present work was the surface modification of cotton and polyester fibers to confer hydro and oil repellency to the fabrics. Sol–gel, previously investigated by the same authors as textile finishing, was here chosen as surface treatment not involving the bulk of the fibers, so fabrics can keep unvaried comfort characteristics. Moreover, it was coupled to post-UV-curing to enhance the finishing adhesion to fibers, improving treatment fastness. Process optimization was in fact focused on an economical and ecofriendly process to obtain an effective finishing with good fastness to washing. 3-(Trimethoxysilyl)propyl methacrylate (MEMO) was used as sol–gel precursor both alone and with Fluorolink® S10, a commercial product from Solvay Solexis (Italy), to obtain an UV-curable modified nanosol to be applied to fabrics with add-ons ranging from 5% to 30% o.w.f. (on weight of fibers). Treated samples were tested by means of contact angle measurements with water and oil while fastness to washing was tested according to ISO standard (till 5 washing cycles). Moreover the modifications that occurred on fiber surface were investigated by FTIR–ATR and XPS while the influence on thermal properties was revealed by DSC measurements. Promising results were obtained in terms of conferred water and oil repellency and treatment fastness, enhanced in particular on UV post-cured samples, as expected.

1. Introduction

In recent years, hybrid organic–inorganic nanocomposites received great interest from both academic and industrial research. At present, they are indicated as the next-generation composite materials due to their effectiveness in dramatically improving many properties of polymers. Moreover the application of nanotechnology has been proven to improve the fabric performances and to confer high durability to fabric modifications thanks to the nanomorphology of the fillers used. Sol–gel technology enables the possibility to tailor surface properties to a certain extent, and to combine different functionalities in a single material [1–5]. At the same time, the application of sols can be carried out with techniques commonly used in the textile industry [6].

Water repellency and oil repellency of textiles are among the most desirable properties for consumers. In many cases a water barrier is achieved by completely covering the open structure of a textile with a dense polymer layer or fluorinated membranes. Nevertheless, these treatments can compromise the peculiar characteristics of fabrics, such as softness or breathability. Due to this reason, the surface modification of fiber materials is an important topic of textile research worldwide. Therefore highly hydrophobic and superhydrophobic fabrics were obtained by hybrid organic–inorganic coatings via sol–gel technique [7–9].

In a previous research work [10,11], the authors carried out some studies about cotton functionalization via sol–gel. Nanosol obtained by TEOS (tetraethyl orthosilicate) and fluoro-carbon polysiloxanes, both laboratory and industrial grades, as co-precursors were applied to cotton fabrics by impregnation and thermal treatment. Good values of contact angles were obtained, this revealed a superhydro- and oleophobic behavior conferred to the surface; nevertheless treatment fastness to laundering was not so good, in particular using the commercial product as precursor.

The application of hybrid organic–inorganic coatings to textiles has been recently proposed for enhancing their thermal stability and flame retardancy [12]. Such hybrid coatings can be obtained by dual-cure processes, where sol–gel reactions of inorganic precursors are coupled with the photopolymerization of reactive monomers and/or oligomers [13]. The photopolymerization or UV-curing process implies low energy consumption, fast curing rate and absence of organic solvents, hence can be considered an economical and ecofriendly alternative to conventional thermal induced polymerization. UV-grafting process was previously widely investigated by the authors as finishing process for textiles [14].

Following the suggestion of dual-cure process, in order to improve the treatment of hydro and oil repellency on the fabrics, in the present work sol–gel and UV grafting were coupled, using as precursors siloxane bearing acrylic group and siloxane with fluorinated segments. In fact one can suppose that after hydrolysis siloxane groups are involved in

* Corresponding author. Tel.: +39 0110904653; fax: +39 0110904699.
E-mail addresses: monica.periolatto@polito.it (M. Periolatto), franco.ferrero@polito.it (F. Ferrero).

http://dx.doi.org/10.1016/j.surfcoat.2014.12.048
0257-8972/

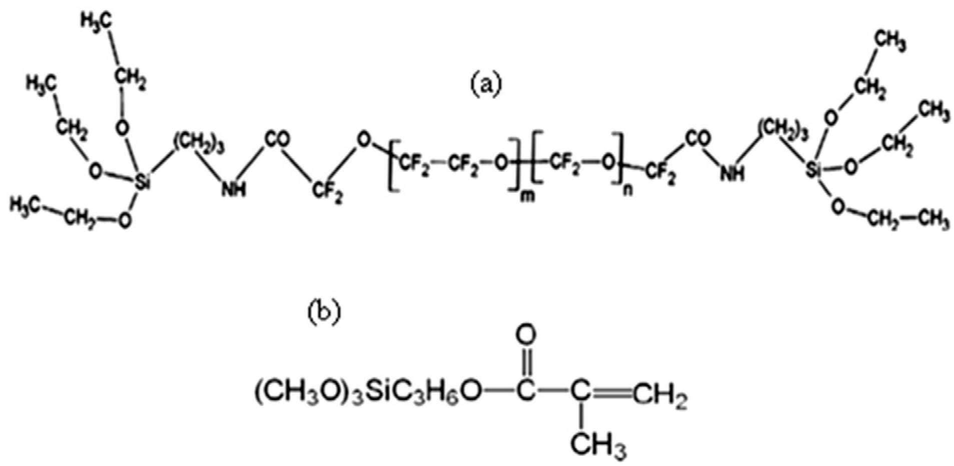

Fig. 1. Molecular structure of (A) Fluorolink®S10, (B) MEMO.

condensation reaction with themselves and with the alkoxy groups of the acrylic monomer; they form inorganic silica clusters and polymeric hybrid segments having a siloxane backbone linked to the organic matrix containing acrylic groups and even fluorinated segments [13]. Subsequently, during the irradiation step, the acrylic groups can copolymerize yielding a network which can be even grafted to the fiber surface.

2. Material and methods

2.1. Sample preparation

Cotton ISO 105-F02 woven fabric, 105 g/m^2 weight, and polyester woven fabric, 170 g/m^2, supplied by EMPA (Swiss Federal Laboratories for Materials Science and Technology) were used as textile substrates. The area of treated samples was about 100 cm^2.

3-Methacryloxypropyltrimethoxysilane (MEMO) pure laboratory grade reagent by Wacker, and Fluorolink® S10, commercial product from Solvay Solexis (Italy) were used as sol–gel precursors. In Fig. 1 the Fluorolink S10 and MEMO molecular structures are reported.

Ethanol 96% vol from Sigma Aldrich was used as dilution media while pH was adjusted by the addition of hydrochloric acid reagent grade.

Two different nanosols were prepared, using MEMO alone or Fluorolink + MEMO as precursors. Sol gel precursors were mixed in alcoholic media so that hydrolysis and condensation reactions occur forming a nanosol. Cotton and polyester fabrics were dipped in the nanosol to adsorb the nanoparticles on the fiber surface by an impregnation time of 15 min; add-ons were fixed to 5%, 10% or 30% o.w.f. (on weight of fibers). Finally drying and curing steps at 120 °C for 1 h were carried out.

A second series of samples was prepared by adding to the nanosol 4% on monomers weight of 2-hydroxy-2-methyl-1-phenylpropan-1-one

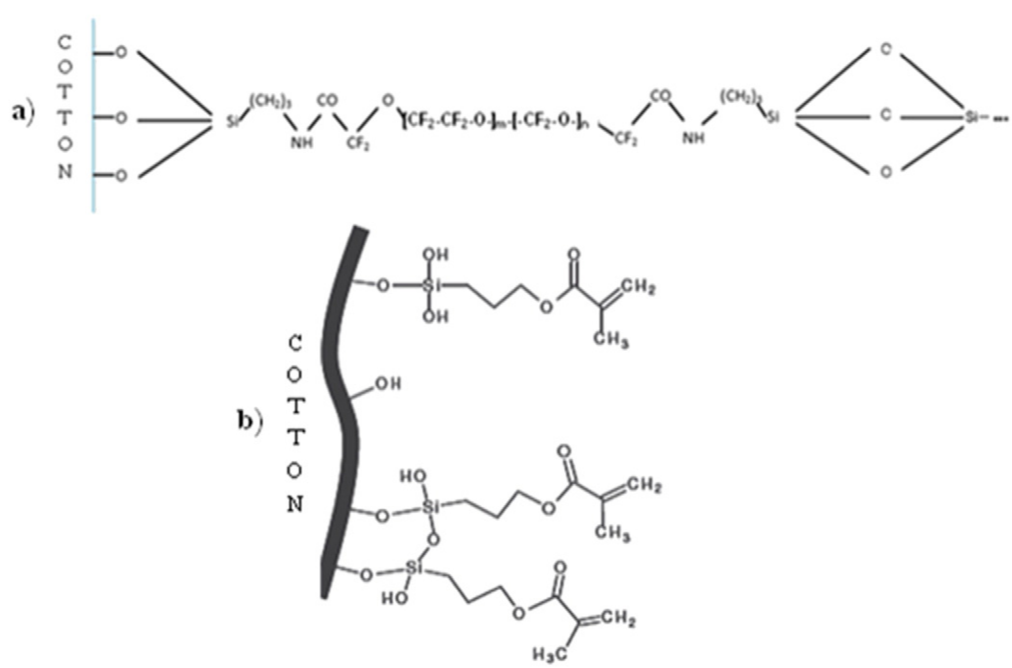

Fig. 2. Grafting between cotton and (A) Fluorolink S10, (B) MEMO.