



# Preparation of silver-plated wool fabric with antibacterial and anti-mould properties



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## ABSTRACT

Wool fabric with multifunctional properties was prepared by a novel metallization method. In this study, wool fabric was firstly treated with tris (2-carboxyethyl) phosphine (TCEP) as a reducing agent to produce thiol-reactive groups on the wool surface. Then, these groups could react with silver ions in the following electroless plating. The results show that this metallized fabric has anti-bacterial activity above 99.9% and anti-mould activity reaches level of 0. This method can also be applied to produce metallization of other keratin fabrics for medical industry.

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## 1. Introduction

Wool fabric is a kind of superior natural textile material due to its excellent characteristics [1] and could form the micro-environment of close to our skin well because it is the same protein composition between wool and human skin surface. However, wool products, other than fabric, like carpets also act as the host of the microorganisms' propagation, which are the nutrients source of worms and bacteria. Hence, antibacterial finishing on wool has gained increased attention. The current approaches to prepare antibacterial fibers are applied by coating [2], pad-dry-cure [3], chemical modification [4] and electro-less plating [5] processes with metal elements [6], photo-catalytic materials [7], and quaternary ammonium agents [8]. Among them, hand feeling is hurt and durability of antibacterial properties is not so good by coating and pad-dry-cure. Chemical modification process can solve this problem but it does damage to fabric's mechanical strength. Silver electro-less plating is an effective way to impart substrate with antibacterial and antistatic properties with good durability.

It is known that electro-less plating can be initiated upon the catalyzed surface, but to textiles, it is not easy to realize due to lack of reactive groups on the fiber's surface, the adhesion between metal layer and wool fabric is inherently poor representing a bottleneck in metallization of textiles. To our knowledge, the metallization of natural

fibers is even less, our group once successfully prepared Ni–P plated wool using chitosan as good media to chelate metal ions [9]. Herein, we propose a novel method to produce silver plated wool fibers by chemical bonding of silver layer and fibers without the usage of noble metal catalyst [10]. Firstly we utilized TCEP to produce –SH groups the wool fiber [11], which will act as seeds to connect with silver ions together with other natural functional groups like –NH<sub>2</sub> and –OH in the wool fibers [12]. After metallization process, the plated silver layer

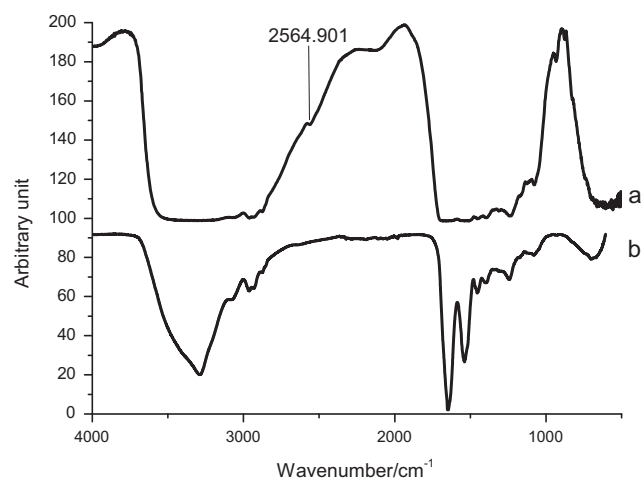
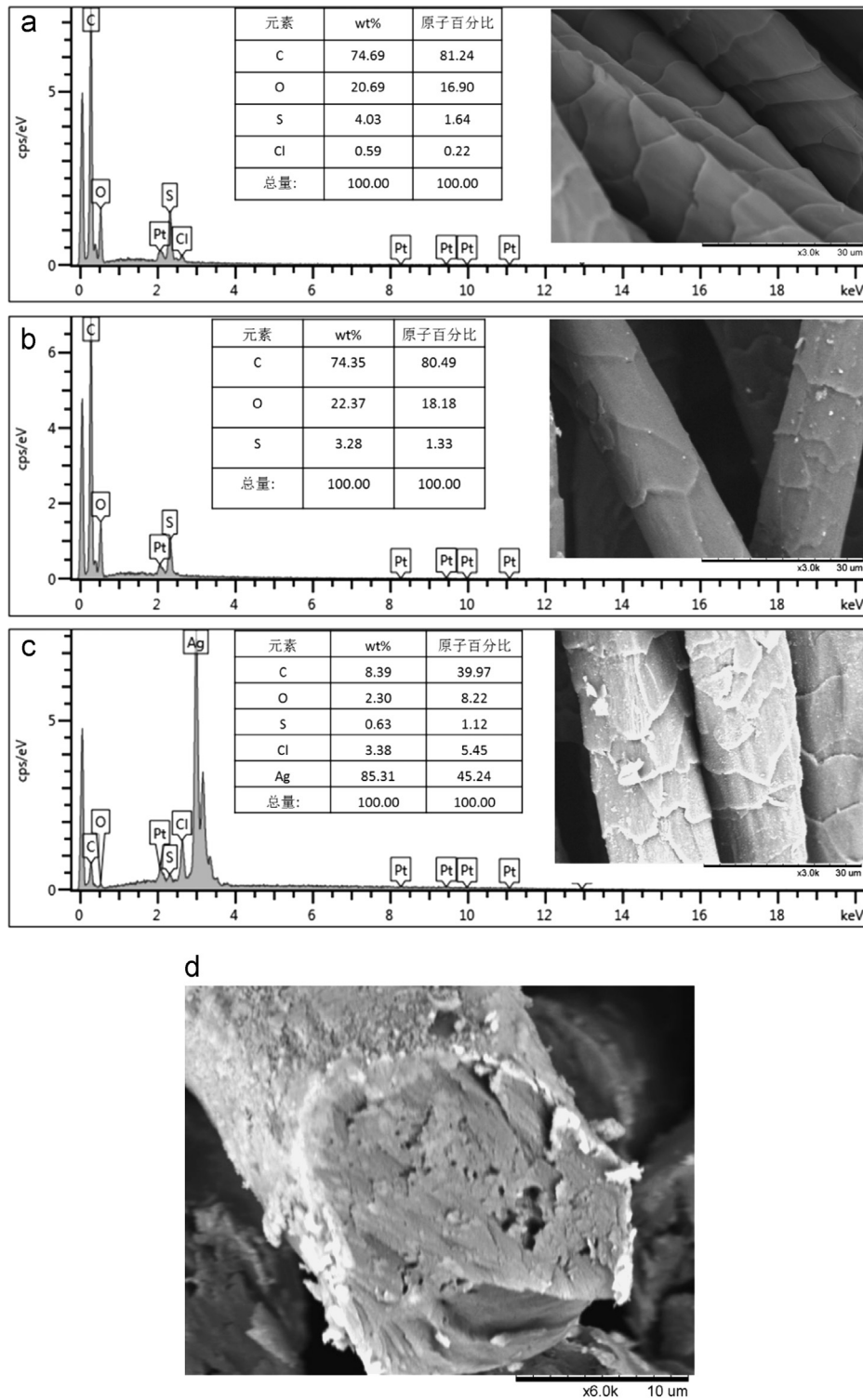


Fig. 1. FTIR spectra of TCEP treated wool fabric (a) and original wool fabric (b).

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**Fig. 2.** SEM micrographs and EDX patterns of original wool fiber (a), TCEP treated wool fiber (b), silver-plated wool fiber (c) and the cross-sectional vision of the wool fabric with silver films (d).

has good adhesion and durability in contrast with those only by physical adsorption or deposition [13].

## 2. Experimental

**Material and methods:** The woven wool fabric is a plain-weave 100% (Merino) of 190 g/m<sup>2</sup> fabric mass, with warp and weft yarn density of 23 yarns/cm and 20 yarns/cm in this test. TCEP was purchased from

Sigma-Aldrich. Ammonium hydroxide and formaldehyde was purchased from the Chinese Medicine Group. Silver nitrate was purchased from Shanghai Institute of fine chemical material. All chemicals were analytic grade reagents, and used without further purification.

Wool fabric was ultrasonically cleaned in ethanol for 5 min and dried at 60 °C before the treatments with TCEP solution. The pretreatment of wool fabric was performed in a water/ethanol (V:V=1:1) solution containing 20 mmol/L TCEP at pH 7.0 for 4 h at room temperature [14]. The solution AgNO<sub>3</sub> (35 g/L) was prepared

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