Nanofinishing antimicrobial textiles by means of aerosol filtration

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Introduction of green principles into textile nanofinishing is a hot topic in nanoscience research today, having a myriad of novel applications (Dolgin, 2015). However, traditional textile nanofinishing (pad-dry-cure) processes have many constraints. Here we implement a sustainable and scalable approach to textile nanofinishing (i.e., introducing well-defined nanoparticles (NPs) into textiles) in a one-step filtration process, which is virtually without environmental impact, as it avoids solvents and circumvents other constraints encountered in wet-finishing processes. As proof of this concept, we investigate the antimicrobial properties of the resulting nanofinished textiles, and show that these are high, albeit the low concentrations employed, and remain high after three washing cycles.

Electrical discharges were used to produce Ag NPs. The generated aerosol NPs were filtered by a set of different textiles. To investigate the filtration efficiency of different textiles, their concentrations at the inlet and outlet of the textile holder were measured using two condensation particle counters (CPC Model 3775, TSI). The filter pressure drop Δp at various face velocities (0.5, 1, 2, 4 cm s^{-1}) was measured using a sensitive handheld differential pressure transducer (Model 521-3, Testo) connected to the upstream and downstream ports of the textile holder. The surface composition and morphologies of NPs on the textile fibres were characterized by means of transmission/scanning electron microscopy (TEM/SEM), small- and wide-angle X-ray scattering (SAXS/WAXS), and X-ray Photoelectron Spectrometer (XPS).

The antibacterial activity (AA) of the fabrics was tested according to a standard method (ISO 20743: 2013) on Gram-negative bacterium *Klebsiella pneumonia* ATCC 4352 (LMG 3128) and Gram-positive bacterium *Staphylococcus Aureus* ATCC 6538 (CECT 239). The washing procedure was conducted according to a standard method (ISO 105-C06:2010).

To summarize, the proposed method produces singlet NPs of high purity (Feng *et al*, 2015) and allows tuning the NP loading profile in textiles in contrast to the traditional wet-finishing routes. Our results can initiate future studies oriented towards the search of a new range of multifunctional textiles, and the exploration of binding methods that could provide alternatives to reduce the nanomaterial release even without the use of any chemicals.

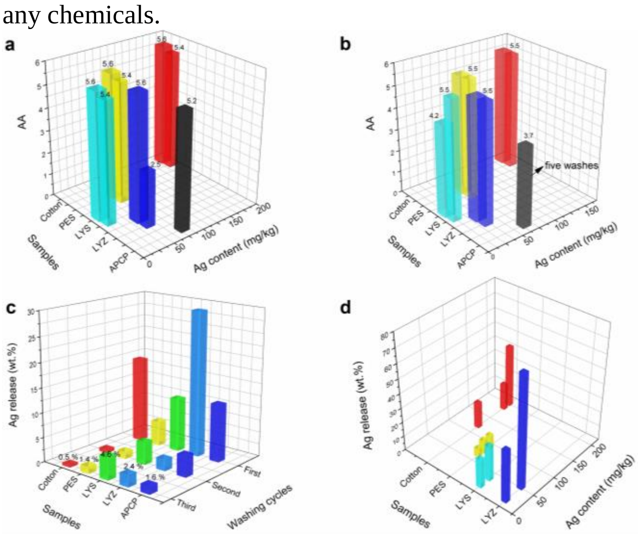

Figure 1. Antibacterial assessment of the textiles treated with Ag NPs against *Staphylococcus Aureus* and *Klebsiella Pneumoniae*. a, antibacterial activity of non-washed textiles versus Ag content; b, antibacterial activity of washed textiles (three and five cycles) versus Ag content. c, Ag release from textiles versus washing cycles. d, Ag release from textiles versus Ag content. The used textiles and their abbreviations are: Cotton, Polyester (PES), Acrylic-Polyester-cotton-polyamide (APCP), Lyocell rayon-Safari (LYS), Lyocell rayon-Zen (LYZ).

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