Development of Antibacterial and UV-protective TiO_2/SiQAC/Ag/textile nanocomposite

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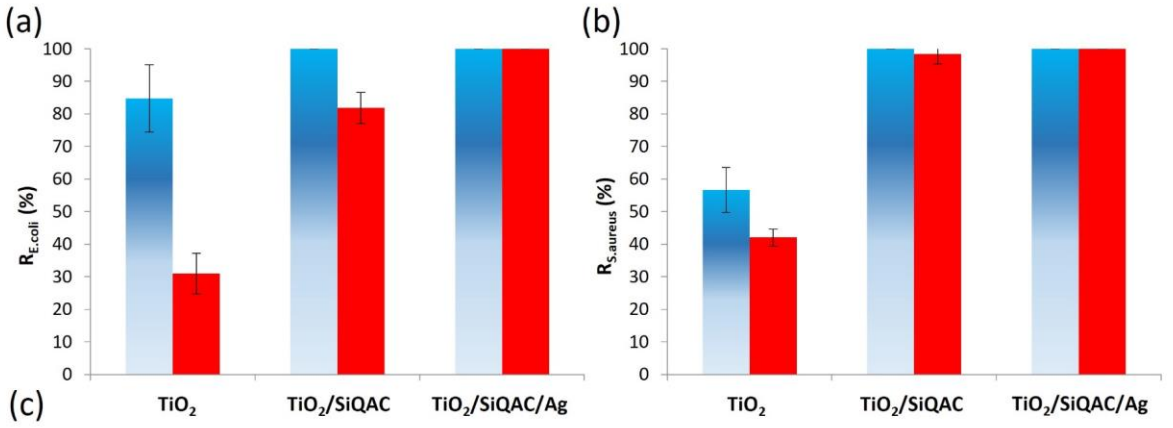
Current approaches and technologies of chemical modification of textiles are not strictly aligned with an environmental, economic and social conception of sustainability when it comes to the production of multifunctional antibacterial and UV-protective textile products with high added benefits. To prevent bacterial infection and UV radiation, dimethyloctadecyl [3-(trimethoxysilyl) propyl] ammonium chloride (SiQAC) in combination with titanium isopropoxide (TiO_2) and $AgNO_3$ was applied to the surface of cotton textiles to develop a multifunctional TiO_2/SiQAC /Ag/textile nanocomposite.

In this work, TiO_2 and SiQAC in a molar ratio of 1:1 were applied to a plain weave cotton fabric in by an *in situ* pad-dry hydrothermal technique. 2.0 mM of $AgNO_3$ was added to produce TiO_2/SiQAC/Ag coated textiles. The treated textiles were dried and cured at 150°C for 3 min. The antibacterial activity of gram-negative *E. coli* (ATCC 35218) and gram-positive *S. aureus* (ATCC 25923), as well as UV protection properties, were evaluated according to ASTM E 2149-01 and AATCC 183 standards, respectively.

The results showed that TiO_2/SiQAC/Ag textile exhibited outstanding antibacterial activity (100% reduction) against *E. coli* (Fig. 1a) and *S. aureus* (Fig. 1b), with a reduction rate close to 100% after 10 washes. UPF values were significantly increased from 4.2 in the unmodified textile to 29.7 in the modified textile (Fig. 1c). The addition of SiQAC in the textile composite impairs its UV protection. However, further addition of $AgNO_3$ increased the UPF value to 26.6. The results showed that UVA and UVB radiation were blocked very successfully in almost all the samples. Moreover, the UV protection of all modified textiles was excellently maintained after 10 washes.



Sample	No. of wash	UVA Blocking (%)	UVB Blocking (%)	UPF
Control	0	72.3	77.3	4.2
TiO_2	0	84.9	97.8	29.7
	10	89.1	98.1	37.1
TiO_2/SiQAC	0	79.4	97.5	19.6
	10	79.9	97.7	20.0
TiO_2/SiQAC/Ag	0	83.9	98.3	26.6
	10	81.0	97.9	21.3

Fig 1. Reduction of (a) *E. coli*, (b) *S. aureus* and (c) mean UPF values of studied textiles (blue = unwashed, red = after 10 washes)

This study concludes that TiO_2/SiQAC/Ag/textile nanocomposite provides outstanding protection against *E. coli* and *S. aureus*. It also enhances UV protection by enabling cooperative activity among TiO_2, SiQAC, Ag and textile surface. The antibacterial activity and UV protection remain almost unchanged even after 10 washes.