# MODIFICATION OF COTTON FABRIC USING A THREE-COMPONENT $Ag/TiO_2/g\text{-}C_3N_4$ COMPOSITE TO IMPROVE PROTECTION AGAINST UV RADIATION

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**AIM:** The aim of this research is to synthesise a novel three-component $Ag/TiO_2/g\text{-}C_3N_4$ composite that provides excellent UV protection for cotton fibres, and to determine whether the presence of Ag and graphitic carbon nitride ($g\text{-}C_3N_4$) in the composite improves the UV protective properties of the single-component $TiO_2$.

**EXPERIMENTAL :** The 100% cotton fabric was chemically modified with a three-component $Ag/TiO_2/g\text{-}C_3N_4$ composite using the pad-dry-cure method. The composite was previously synthesized from precursors of $AgNO_3$ and titanium(IV) isopropoxide in combination with $g\text{-}C_3N_4$ in a water/isopropanol solution using ascorbic acid and ethanoic acid as reducing agents at 70 °C. Single-component $TiO_2$ and the two-component $Ag/TiO_2$ composite were also applied under the same conditions. Sample codes: untreated CO(UN), chemically modified CO($Ag/TiO_2$/g-CN) ), CO($TiO_2$), and CO($Ag/TiO_2$).
The morphology and chemically composition of the samples were examined by SEM, EDS and FTIR analyses. The surface plasmon resonance was studied by digital microscopy. Optical properties were determined by UV/VIS spectroscopy. The UPF values and the UPF categories of the samples were estimated according to the SIST EN 13758-1: 2002 and the AS/NHS 4399: 2017 standards, respectively.

**RESULTS AND DISCUSSION:** The results are presented in Figures 1 to 4 and in Table 1.

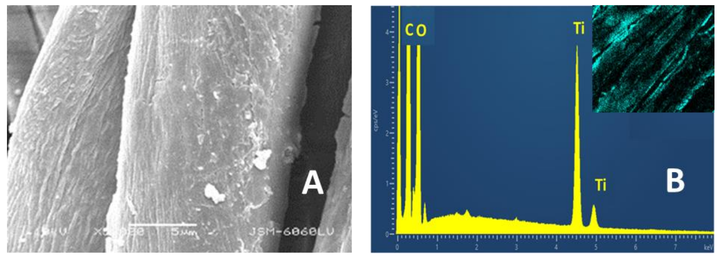


**Figure 1. SEM image (A) and EDS spectrum (B) of CO($Ag/TiO_2$/g-CN).**

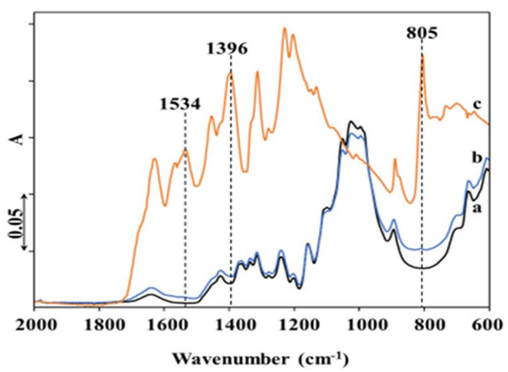


**Figure 2. FTIR spectra of CO(UN) (a); CO($Ag/TiO_2$/g-CN) (b); and $g\text{-}C_3N_4$ powder (c).**

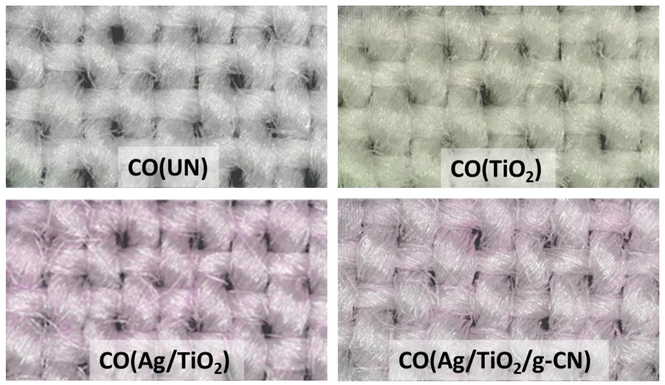


**Figure 3. Digital microscope images of the samples.**

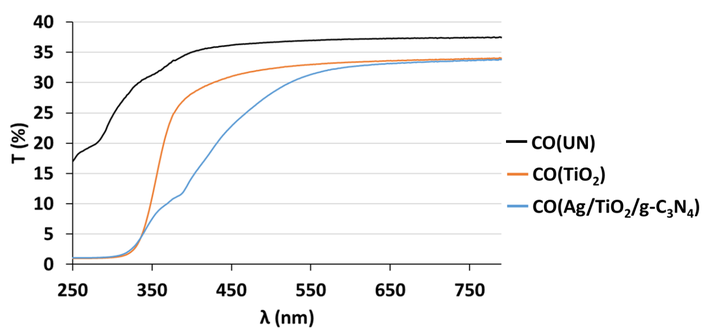


**Figure 4. Transmission spectra of CO(UN), CO($TiO_2$) and CO($Ag/TiO_2$/g-CN).**

**Table 1. UPF values of the samples.**

| Sample | UPF | Protection category* |
|---|---|---|
| CO(UN) | 3.75 | I |
| CO($TiO_2$) | 40.31 | E |
| CO($Ag/TiO_2$/g-CN) | 46.35 | E |

*I – insufficient protection, E – excellent protection

The presence of the $Ag/TiO_2/g\text{-}C_3N_4$ composite on the cotton fibres was demonstrated by the presence of the $TiO_2$ component in the EDS spectrum (Figure 1), the same characteristic bands of $g\text{-}C_3N_4$ as for the $g\text{-}C_3N_4$ powder in the FTIR spectrum (Figure 2) and the surface plasmon resonance of Ag (pink colouration) in the digital microscope images (Figure 3).

The results of the UV/VIS measurements show that the transmission of the CO($Ag/TiO_2$/g-CN) sample is significantly lower than that of the CO($TiO_2$) sample in the UVA range, which is due to the presence of the heteroaromatic structure of $g\text{-}C_3N_4$ (Figure 4). Since the UV protection of the CO(UN) sample is insufficient, the UPF value of the CO($TiO_2$) sample reaches a value of 40 and is even higher for the CO($Ag/TiO_2$/g-CN) sample, which represents excellent UV protection (Table 1).

**CONCLUSION:** A novel three-component $Ag/TiO_2/g\text{-}C_3N_4$ composite, which provides excellent UV protection for cotton fibres, was successfully synthesised. The individual compounds in the composite have an additive effect, which is confirmed by the higher UPF value of the CO($Ag/TiO_2$/g-CN) sample compared to the UPF values of CO($TiO_2$), CO(g-CN) and CO(Ag) samples, which are 40.31, 9.81 and 4.27, respectively.

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