

ABSTRACT

In this work, titanium dioxide (TiO_2) nanoparticles have been prepared through bottom-up chemical reaction method using sol-gel technique with various starting materials such as Titanium tetraisopropoxide (TTIP), Tetrabutyl orthotitanate (TBOT) and Titanium tetraethoxide (TTE). Nanoparticles prepared using these precursors have also been further subjected to modifications using the modifier of (3-Aminopropyl) triethoxysilane and the cross-linker hydrogen silicone oil. The six varieties of TiO_2 nanoparticles prepared before and after chemical modifications (T_{u1} , T_{u2} , T_{u3} , T_{m1} , T_{m2} & T_{m3}) were subjected to characterisation for nanoparticle size and distribution using Particle Size Analyser (PSA), crystal structure information using X-ray Diffraction spectroscopy (XRD), chemical information using Attenuated Total Reflection-Fourier Transform Infrared Spectroscopy (ATR- FTIR), the surface morphology of textile substrate was studied by Field Emission Scanning Electron Microscopy (FESEM) and the elemental composition of the particles through Energy Dispersive X-ray spectroscopy (EDX) analytical technique.

The unmodified and modified nanoparticles (T_{u1} , T_{u2} , T_{u3} , T_{m1} , T_{m2} & T_{m3}) were applied on a selected textile substrate of Polyester / Cotton (P/C) fabric for imparting functional properties of the TiO_2 nanoparticles such as photocatalytic activity, UV protection properties, antimicrobial and soil release properties. Other physical testing of textiles such as fabric areal density, thickness, crease recovery, drape coefficient, tensile strength, tearing strength, elongation, air permeability and whiteness index have also been studied as an effect of the treatment.

The average sizes of the unmodified nano TiO₂ particles were 25 nm, 57 nm and 45 nm for the precursor types T_{u1}, T_{u2} and T_{u3}, respectively. After silane modification, the average particle sizes of the TiO₂ particles were 18 nm, 42 nm and 29 nm for the particles out of the process types T_{m1}, T_{m2} and T_{m3}, respectively. The size distribution range for unmodified TiO₂ nanoparticles was from 10 nm - 60 nm (T_{u1}), 35 nm - 80 nm (T_{u2}) and 25 nm - 80 nm (T_{u3}). Similar to that, the size distribution range of silane modified TiO₂ nanoparticles was 10 nm - 30 nm (T_{m1}), 35 nm - 50 nm (T_{m2}) and 20 nm - 40 nm (T_{m3}). The functional properties of the nano TiO₂ treated fabrics such as, photocatalytic activity, UV protection property, antimicrobial and soil release property have also been found to enhance due to the nanoparticles treatment. Excellent photocatalytic activity, UV protection, antimicrobial activity and soil release action was noticed in silane modified nano TiO₂ treated fabric when compared with unmodified TiO₂ treated and untreated fabric samples. In these studies, the effect of TiO₂ application concentration, with respect to fabric weight, was studied for 1 %, 1.5 % and 2 % concentrations along with the wash durability information. It was found that the particle size influences in most of the cases on imparting the proposed active properties in textiles. PSA, FESEM, EDX, ATR-FTIR, XRD studies reveal the facts about the TiO₂ nanoparticles and its presence over the textile substrate. The basic fabric property studies reveal little alteration in the properties as an effect of the application of the nanoparticles. The results were also statistically analysed.