Development of Superhydrophobic Cotton Textiles based on Zinc Oxide and Silica Nanoparticles

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Abstract

The production of self-cleaning textiles is of great interest to the textile industry. Such textiles should be water-repellent, resistant to washing and abrasion and obtained by environmentally friendly processes. The search for viable alternatives to Teflon® for the production of superhydrophobic textiles has been attracting much interest both for commercial reasons and the need of an environmental sound alternative to the use of fluorocarbons. Methodologies are generally based on mimicking the lotus leaf effect in a way to produce nano/micro-structured surfaces and coat them with a hydrophobic layer. Several types of nanoparticles (NPs) like silica NPs, ZnO NPs and TiO_2 NPs[1] may be used to achieve this nano/micro-nanostructured surface, but the most successful approaches have relied on silica NPs[2]

Cotton textiles were modified with ZnO NPs (Fig. 1) synthesized by a seeding method[3] and silica NPs synthesized using the Stober method[4]. The nanoparticles were deposited on the textiles by dip-padding techniques, followed by the application of a hydrophobic monomer, DTMS (dodecyltrimethoxysilane).

Scanning Electron Microscopy (SEM) micrographs (Fig. 2-3) show that both types of NPs are deposited directly onto the cotton fibre surface, and EDS analysis confirmed the presence of zinc and silica on the samples. The contact angles for water droplets placed on ZnO NP-treated cotton textile surfaces with a hydrophobic DTMS layer were up to 150° (Fig. 4), while for surfaces treated with silica NPs, the contact angle reached 160°. The control sample, only with a DTMS layer, showed a contact angle of 130°. Experimental conditions for NPs and DTMS application were used and alternatives to DTMS are currently under investigation with a view to obtain a commercially viable solution that does not involve fluorocarbon compounds. This nanoparticles are being applied on large scale on Devan-Micropolis laboratory by dip-padding process for commercial use on several types of textiles. The use of new compounds like cross-links and new hydrophobic monomers are on study focus, trying to develop a better and new material. Samples are tested for abrasion, water and oil durability and water resistance,

References

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[3] Xu and Z. Cai, Appl. Surf. Sci., 254 (2008) 5899-5904

[4] With, G. et al, Nanoletters, 5, 11 (2005) 2298-2301

Figures

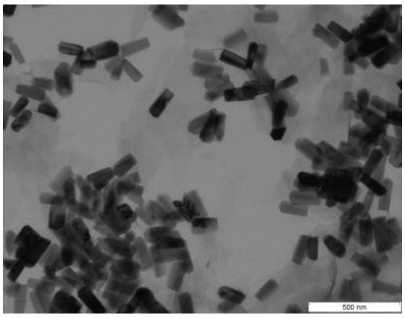

Figure 1- Transmission Electron Microscopy (TEM) image of ZnO nanoparticles used for textile functionalization

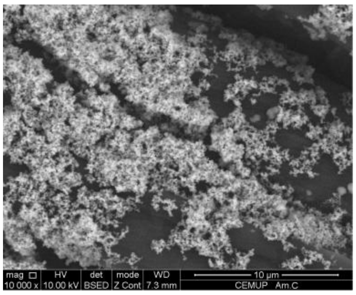

Figure 2 – SEM image of ZnO nanoparticles deposited on cotton textile and treated with DTMS

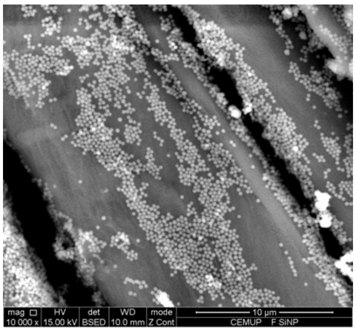

Figure 3 – SEM image of silica nanoparticles deposited on cotton textile and treated with DTMS

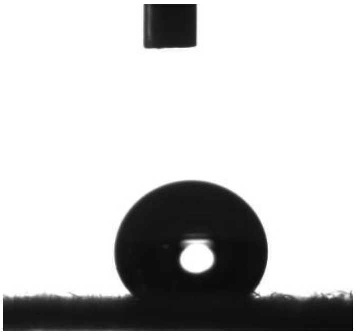

Figure 4 – Contact angle of 150° of a water drop on cotton textile functionalized with ZnO nanoparticles and DTMS.