Gashti, J Textile Sci Eng 2014, 4:2
DOI: 10.4172/2165-8064.1000e120

Journal of Textile Science & Engineering

ISSN: 2165-8064

Editorial Open Access

Nanocomposite Coatings: State of the Art Approach in Textile Finishing

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It is my great pleasure to provide my first editorial for the Journal of Textile Science & Engineering which is published by the OMICS group as a well-known publisher for the global community. Submission of papers in this Journal is growing too fast due to up-to-date scopes, routine publication, distinguished editorial board members as well as valuable papers published. This multidisciplinary open-access textile journal encompasses all branches of textile engineering, textile chemistry and textile technology. Open access platform is important these days for scientists as it will address many aspects of science.

Here, I would like to consider a topic, nanocomposite coating for inducing functionalized textile products as a short summary. Today, we know that nanotechnology has been considered extensively in textile engineering in order to perform new functionalities. Nanoparticles as ultrafine materials can modify surface and interface of textiles. They can be used as fillers in the synthetic fiber production line or can be synthesized at the surface of fibers in order to induce several properties such as antibacterial, superhydrophobic, fire retardant, self–cleaning, superhydrophilic, moth-proofing, electromagnetic shielding, and electrical conductivity [1]. Several methods have been promoted to generate nano-coatings on textiles including sol-gels technique, magnetron sputter coating, layer-by-layer (LBL) technique and crosslinking by polymers [2].

In sol-gel method, metal salts with oxidizing or reducing agent used to produce colloidal solutions of typically metal oxide nanoparticles in either aqueous or organic solvents which constitute nano-sols. Textiles are subsequently treated with these sols using a simple pad or dip coating method [3]. Many inorganic nanoparticles are synthesized and titanium dioxide is chosenmostly for synthesis by this method. Other nanoparticles considered here are spherical silica, zinc oxide and aluminium oxide [4-6].

Synthesis of nano-coatings by utilizing the Physical Vapor Deposition (PVD) method is another environmentally friendly physical approach for producing thin film on fibers. A magnetron sputter system in a vacuum process provides a high voltage across a low-pressure gas. Reactive gas molecules are then deposited on textiles as metals and metal oxides. Some general examples of nanoparticles deposited by this method are Zinc Oxide (ZnO), copper oxide, iron oxide and silver films with nano-layer thickness. Functional properties of layers produced by this method depend on thickness of coating and duration of sputtering [7-10].

Another state of the art approach in this field is layer-by-layer deposition method for fabrication of assembled thin nano-layers. It is worth mentioning that this method is controlled by multi composite cycles of molecular assemblers and nano-films using polyelectrolytes and nanoparticles, alternatively. Poly (diallyldimethylammonium chloride) and 2,3-epoxy propyl trimethylammonium chloride are examples of assemblers used in combination with different nanoparticles [11-13].

Here I should mention another simple method, which our group mostly utilized for nanocomposite coating on textile substrates using mixture of cross-linkers and nanoparticles. Nanoparticle finishing is not generally a permanent process on textiles showing poor fastness against washing, thus we have suggested using cross-linkers or binders for fixation into the textiles. We have used carboxylic acids as cross-linker for esterification of cotton and wool in order to entrap nanoparticles within these networks. Embedding of carbon nanotube, nano-silica, silica-kaolinite or nano-zirconium oxide with 1,2,3,4-butanetetracarboxylic acid, citric acid or succinic acid are developed by our group for successful multi-functionalization of cotton and wool [14-17]. Other groups also used cross-linkable polysiloxane and titanium dioxide nanoparticles for such nanocomposite preparations. All these cross-linkers showed good or excellent wash fastness property of nanoparticles on textiles [18].

Other chemical methods which cannot be categorized here as direct nano-coatings, are ozone gas treatment, supercritical carbon dioxide, enzymatic modification, and alkaline or acidic etching. They can be used for pre-treatment and subsequent nano-coating processes [19].

Finally, surface functionalization of textiles can be utilized by the aid of other physical methods for obtaining smart textiles based on plasma process. Herein, a dynamic mixture of free radicals or polymeric monomers is provided during plasma in low pressure or atmospheric pressure which can be done in low-frequency, radio-frequency, or microwave. Different functionalized textiles can be achieved by this method including shrink-resistance, anti-scratch, superhydrophobic, superhydrophilic, and fire resistance [20]. Corona discharge and laser treatments are other physical methods that can induce Nano topographies on textile surfaces [21]. All these physical methods mentioned here, can also be applied as pre-treatment methods for subsequent coating of nanoparticles on substrates.

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Received February 08, 2014; **Accepted** February 08, 2014; **Published** February 10, 2014

Citation: Gashti MP (2014) Nanocomposite Coatings: State of the Art Approach in Textile Finishing. J Textile Sci Eng 4: e120. doi:10.4172/2165-8064.1000e120

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