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PROMOTION OF MEANS AND INTERFACES CONNECTING NANOPARTICLES TO TEXTILE SUBSTRATES

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ABSTRACT

The use of nanotechnology in textiles is strategic and allows materials produced to become multifunctional. This development of the textile markets is connected with an ever growing number of new features for highly specific applications. At the same time, there is a restriction on new types of synthetic fibers. In this context, the surface modification of fibers became one of the most important topics for the creation of innovative textile products. Besides other techniques, the functionalization of fibers through the concepts of nanotechnology is part of this project to develop over three years. The coatings based on hybrid inorganic-organic polymers have a huge potential for creative modification of surface properties and can be applied with a relatively low technical effort and moderate temperatures. Attempts to change these systems through a variety of inorganic or organic substances may lead to a wide range of additional features that are increasingly demanded by the textile industries worldwide.

The application of polymeric nanocomposites with organic or inorganic particles of different sizes and with different chemical behaviors are currently the target of innovative scientific research. The different functional nanofinishing possible, such as anti-microbial, UV protection, flame retardation, among others, arise from the powerful combination of "nanocomposite polymer - inorganic or organic particle", since different combinations of this system leads to a number of additional features.

Nanoparticles have the potential to be used to obtain multiple functionalities in textile substrates but do not have ways to connect directly to these materials, whether natural, artificial or synthetic. This means that there is a need to create films that will act as a mean of homogeneous dispersion of nanoparticles, without damaged properties of textile materials which are concerned with looks and comfort, in case you're dealing with applications in apparel.

The ultimate goal of the proposed study is to establish the fundamental theoretical principles for understanding the binding mechanisms of nanocomposites to textile substrates, the formulation of good and stable dispersions of nanoparticles in different polymer matrices, develop and optimize the process for the production of textile nanofinishings using polymer nanocomposites based copolymers in combination with inorganic nanoparticles to improve textile functionality and to UV protection, anti-bacterial, flame retardant, anti-odor finishes and water repellency.

More specifically, highlighting four areas of research:

- Get hydrophobic polymers that can behave as a matrix for the dispersion of nanoparticles with high binding capacity to natural and synthetic textile materials, giving them the properties of highly durable water repellency associated with other functions linked to the behavior of nanoparticles.
- Get hydrophilic copolymers that behave as a matrix for the dispersion of nanoparticles with high capacity to bind to textile materials, giving them moisture regulation properties, combined with other functions linked to the performance of the nanoparticles.
- Modify textile substrates by chemical and physical methods (like DBD) to promote links irreversible nanocomposite formed by the polymer and the nanoparticles dispersed in it.
- Achieve permanent functional properties of natural and synthetic textile materials by selecting the appropriate system of nanoparticles dispersed in the polymer matrix and control the functional characteristics of the final product according to international standards.

The overall objective of the present project is the development of nanofinished functional textiles based on polymer nanocomposites, with established conditions

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for permanent adhesion to the substrate and blocking of the nanoparticles into the the matrix.
The use of polymeric matrices gives high potencial of functionalization namely through responsive polymers and hydrophilic/hydrophobic products. The selection is made pointing out transparency, stability to external agents and adequability to industrial processing in textile industry.

Studies were made for UV protection with thin and thick polyamide textile fabrics treated with different polymeric nanocomposites. Tests with different concentrations of ZnO, Al_2O_3, SiO_2 and TiO_2, dispersed in PMMA were performed. Samples were prepared to further finishing with/without DBD plasma treatment. Good dispersion of nanoparticles in the polymer has been achieved giving well distributed values for UV protection factor. Results reveal:

- DBD treatment has strongly modified PA 6.6 fibers, with surface roughness evaluated by SEM and AFM analysis. Functionalities, as superhydrophobicity and self-cleaning, can be added to the substrate regarding the rough morphological features after plasma and nano finishings.
- High level of UV protection is achieved in polyamide 6.6 fabrics using the polymeric nanocomposites ZnO-PMMA and (1%) TiO_2-PMMA.
- For the nanocomposites Al_2O_3-PMMA and SiO_2-PMMA the effect is not so pronounced.
- The increase in UV protection functionality is generally higher for higher concentration of nanoparticles in PMMA matrix and for thicker fabrics.
- UV protection is eventually more uniform and also more resistant to washing in DBD treated fabrics.
- Durability of UV protection with ZnO-PMMA stands up to ten washing cycles becoming less effective for more than ten washing cycles.
- Durability of UV protection given by TiO_2, SiO_2 and Al_2O_3 in PMMA is good facing abrasion and washing conditions.

Further developments intend to clarify and to improve anchoring mechanisms in order to ensure a much better adhesion of the nanocomposite to the textile substrate, either hydrophobic as polyamide 6.6, or hydrophilic as in cellulosic fibers, for example.
The responsive polymers will be used as polymeric matrices in order to get high level of active/reactive functionalities, as UV protection, temperature and humidity control.