

ECOTEXNANO : SAFE USE OF NANOPARTICLES IN THE TEXTILE FINISHING INDUSTRY

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1. Introduction

The changes in human life style have developed a need for innovation towards more comfort and new technology. On the other hand there is an increasing attention towards environmental and ecotoxicological aspects, which requires an efficient use of resources and a safe use of chemicals. In the whole of these innovations nanotechnology plays a vital role. Nanotechnology involves materials or devices possessing dimensions between 1 and 100 nm. On the nanoscale, material properties can be significantly different than on the normal scale.

Nanomaterials are already being used in a variety of products, thanks to their many interesting possibilities. The use of nanotechnology is also increasing in the textile industry as they allow textiles to become multifunctional. Some of the properties that can be conferred by incorporating nanomaterials into textiles are antimicrobial properties, UV protection, easy cleaning, water and stain repellency and anti-odour.

Although nanomaterials are not intrinsically dangerous, there is a major concern about the long-term effects that a wide use of nanomaterials might have. However, there is only little data available on this issue. Therefore the EcoTexNano project has been initiated. The aim of EcoTexNano is to improve the environmental performances of best innovative solutions in the field of technical textiles incorporating nanoparticles. During the project, environmental, health and safety impacts will be assessed in the manufacturing operations, promoting the integration of green technologies.

2. Functionalities of nanotextiles

By applying nanomaterials additional functionalities are generated for textiles, and to increase in this way the value or the durability of the final product. Another asset is the possible reduction of the environmental impact throughout the lifecycle of fabrics containing soil release or antimicrobial properties, because these require a limited number of washing cycles.

The table below summarizes some properties that can be incorporated by the use of nanomaterials. These materials can either be integrated into the fibre or applied as a coating onto the textiles.

Table 1: the application of nanomaterials in textiles

	Application in textile	Nanomaterial used
1	Electro-conductive and antistatic	carbon black, carbon nanotubes (CNT), Cu
2	Increased durability	Al ₂ O ₃ , SiO ₂ , CNT, ZnO, polybutyl acrylate
3	Antibacterial	Ag, chitosan, SiO ₂ (as matrix), TiO ₂ , ZnO
4	Self-cleaning / dirt and water repellent	CNT, fluoro acrylate, SiO ₂ (as matrix), TiO ₂
5	Moisture absorbing	TiO ₂
6	Improved staining / reduce fade	carbon black, nanoporous hydrocarbon on nitrogen coating, SiO ₂ (as matrix)
7	UV protection	TiO ₂ , ZnO
8	Fire proof	CNT, boroxosiloxane, montmorillonite (nano clay), Sb ₂ O ₃

The EcoTexNano project will emphasize the following properties:

ANTIMICROBIAL

The most common method is the use of biocides containing silver. There are other types of products such as zinc or chitosan acting in different ways such as attacking the cell membranes of bacteria and degrading them. The antimicrobial property of silver is well-known. Silver is one of the best metals with antimicrobial activity against gram-negative and gram-positive bacteria.

Some antimicrobial products based on this compound are usually applied in medical textiles, home textiles (towels, bedding, curtains...), clothing (military uniforms, sportswear, underwear...).

FLAME RETARDANCY

There are several mechanisms to create a flame retardant activity:

- a thermal insulation barrier is created by an intumescent reaction;
- some substances work as diluents of a combustible gas;
- some chemicals generate radicals on the surface with much lower potential to propagate combustion.

SOIL RELEASE

Soil release is one of the properties of easy-care finishing and is commonly known as a finishing with a self-cleaning effect. A soil release finishing behaves differently depending whether it is in contact with air or with water.

UV PROTECTION

The ultraviolet protection factor (UPF) depends on the construction, composition and swelling capacity of the fibres, on the colour, and on the presence of optical brighteners and ultraviolet absorbers in the finishing product. UV protection of a fibre can be improved by incorporating of TiO₂ in its structure and/or by providing sufficient weight to the fabric. In summer however, light-weight fabrics are preferred, and fabrics finished with UV absorbers and stabilizers offer good performance.

3. Environmental and health aspects

The impact on health and environment, during a long-term use of nanotechnology is a major source of concern. It appears that the most critical steps in the entire lifecycle of textiles include finishing, washing and disposal. Indeed, during these steps the risk of exposure of workers to nanomaterials and/or the release of nanomaterials into the environment are the greatest.

Nanomaterials mainly enter the body through the skin or by inhalation. Studies on rats exposed to chronic inhalation of TiO₂ and carbon black have showed clear

effects such as inflammatory reactions and tumours. However it remains unclear whether human exposure to everyday life concentrations of nanomaterials would lead to similar effects, as these amounts would be much lower. Concerning dermal uptake, studies have showed that the skin is a good barrier against nanomaterials such as TiO₂ and ZnO. Other nanomaterials have the potential of penetrating deeper into the skin and even entering the bloodstream.

For the environmental impact of nanomaterials, some of the main routes could be the treatment of wastewaters containing nanoparticles or the incineration of nanoparticles present in waste. It must be taken into account that the sludge from the wastewater treatment or ashes from the incinerator could contain nanoparticles. This must be taken into account when processing these residues.

4. Project objectives

In order to further develop the use of nanoparticles in textiles and to address these major concerns about health, safety and environment, EcoTexNano has defined the following goals:

- Improve the value of textile products, by conferring interesting properties to textiles through the application of nanomaterials. EcoTexNano will focus on fire retardancy, antimicrobial, soil release and UV protection.
- Identify and reduce the environmental, health and safety impacts by carrying out a comprehensive life cycle assessment and risk assessment. The risk- and lifecycle assessment will not be limited to nanotextiles. Also the conventional finishes conferring the same functionalities will be examined.

The objective of the **risk assessment** is to assess the potential health and safety risks posed on workers during the textile finishing process. The risk assessments includes three major subtasks:

- a hazard assessment of the substances,
- an assessment of the exposure, completed by exposure modelling,
- an assessment of the risk mitigation, in which the effectiveness of a number of risk mitigation strategies will be evaluated.

The **life cycle assessment** consists of an assessment of the environmental impacts during the later steps of the textile creation chain, where the finishing occurs.

- Run two pilot-scale trials to provide evidence of best practice in the application of nanobased techniques compared to conventional finishing chemicals.

- Increase the knowledge of nanomaterials, its properties, the health-, safety- and environmental impacts. By doing so, EcoTexNano aims to increase consumer awareness about nanomaterials, and wants to contribute to the development of human health and environmental EU policy, such as REACH, BREF for the textile sector, regulations of biocidal products and CLP regulation.

The final project results will be assembled in a user-friendly, web-based tool to support future design and implementation of textile finishing processes for nanomaterials.



Fig. 1: pilot scale trials

Vincolor/Crevin is a family company that is dedicated to the production of upholstery fabrics. The company itself is completely vertical, from product development to weaving and finishing.

Piacenza- Cashmere is a manufacturer of fine woolen fabrics, leader in the top segment of noble fibre fabrics for luxury market, and pure cashmere knitwear. It is the supplier of fabrics to all world-leading fashion brand manufacturers.

EcoTexNano is coordinated by LEITAT Technological Center, leading a consortium formed by Piacenza Cashmere, Vincolor SA, Itene and Centexbel.



Resource:

Fact Sheet Nano products: Use of nanomaterials in textiles, Umweltbundesamt, Dessau (Germany) , 2013

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