INNOVATIVE TOOL TO IMPROVE RISK ASSESSMENT AND PROMOTE THE SAFE USE OF NANOMATERIALS IN THE TEXTILE FINISHING INDUSTRY

ecotex nano 2017

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STATE OF THE ART

The textile sector plays a crucial role on the economy in numerous regions of the EU-27. After China, the EU is the world´s second largest exporter of textile products with 31% including intra-EU trade. In Europe, this sector has been subject to a series of radical transformations over the last years due to a combination of technological changes, evolution of production costs and the emergence of international competitors. This economic success story has a significant adverse environmental and social footprint across it global lifecycle with rising consumption being a key factor in this.

In response to competitive challenges, the textile industry in Europe is improving its competitiveness by ceasing mass production and simple fashion products and concentrating instead on higher value-added sustainable products.

THE PROBLEM

The main problem that has impulsed ECOTEXNANO is the environmental and health impacts of the Textile finishing industry. The main environmental impacts are related to the production, processing and finishing of textiles and possible health impacts related to the use of the products themselves. In many cases these two impact areas overlap as they derive from the use of certain chemicals and other substances which may have both environmental and health impacts.

The key environmental and health impacts related to the textile finishing industry are:

- Chemicals substances including bulk substances and substances at the nanoscale used in the processing of textiles.
- Energy use and generation of Greenhouse Gas (GHG) emissions from washing (water heating) and drying of clothing.
- Energy use, resource depletion and generation of GHG emissions from processing fossil fuels into synthetic fibres e.g. polyester or nylon.
- Water use, toxicity, hazardous waste and effluent associated with production stage pre-treatment chemicals, dyes and finishes.

THE PROJECT

The overall aim of ECOTEXNANO is to improve the environmental performance of best innovative solutions that are emerging with regard to technical textiles that incorporates nanoparticles in the textile finishing industry. The project has addressed four technical properties: flame retardant, soil release, antimicrobial and UV protection. Environmental, health and safety impacts have been assessed into its manufacturing operations, encouraging the integration of green technologies.

The project has addressed various nanomaterials. From the large variety existing on the market, the project has selected a few based on precise criteria:

- Commercial availability
- Human health and environmental risks
- Environmental impacts
- Performance of nanomaterial in textiles
- Price of formulated nanofinishing products
- Feasibility to apply in pilot scale trials
- Level of transferability
- Availability of data

Basedonsuchcriteria,thefollowingnanomaterials have been selected:

Functionality	**Nanomaterial**
Flame retardant	**Nanoclay**
Soil release	**C6 based fluorochemical**
Antimicrobial	**Silver**
UV protection	**Titanium dioxide**

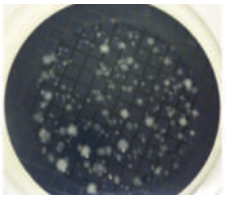
OBJECTIVES

Nanomaterials are not intrinsically hazardous per se. However, there is a need to take into account specific considerations in their risk assessment. In order to address this major concern and considering the priority areas of LIFE+, the key aims of ECOTEXNANO are:

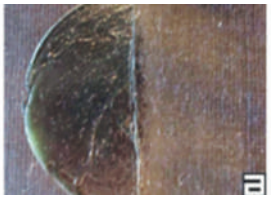
- Provide the textile finishing industry a user-friendly tool to improve the knowledge on risk assessment of nanomaterials and to promote the safe use along their life cycle;
- Identify and reduce the environmental, health and safety impacts carrying out a comprehensive Life Cycle Assessment and Risk Assessment of the selected nanomaterials. The analysis allows quantifying the environmental impacts of the use of nanomaterials in substitution of bulk substances, and to guarantee that these nanomaterials do not pose risk on health and environment;
- Demonstration of pilot scale trials in order to provide evidence of best practice in the application of nano-based techniques comparing with the conventional finishing chemicals;
- Increase the professional´s knowledge base concerning nanomaterials for the further development of human health and environmental EU policy such as REACH, Regulation of biocidal products and CLP Regulation, as well as the BREF for textile sector;
- Improve the competitiveness of the EU textile sector, obtaining a higher value product, far from low cost textiles that come from outside the EU;
- Exchange data and disseminate the project results for potential stakeholders such as competent authorities (i.e ECHA, JRC, etc).
- Increase consumer´s awareness on the HSE impacts of the textile sector using nanomaterials.

FLAME RETARDANT

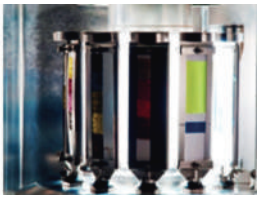
ANTIMICROBIAL



SOIL RELEASE



UV PROTECTION



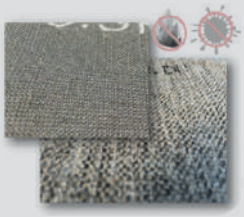
EXPERIMENTAL WORK

FABRICS

In the field of the textile finishing production, ECOTEXNANO has been focused on two types of fabrics:

UPHOLSTERY FABRICS

2 functionalities:
- Soil-release
- Flame retardant

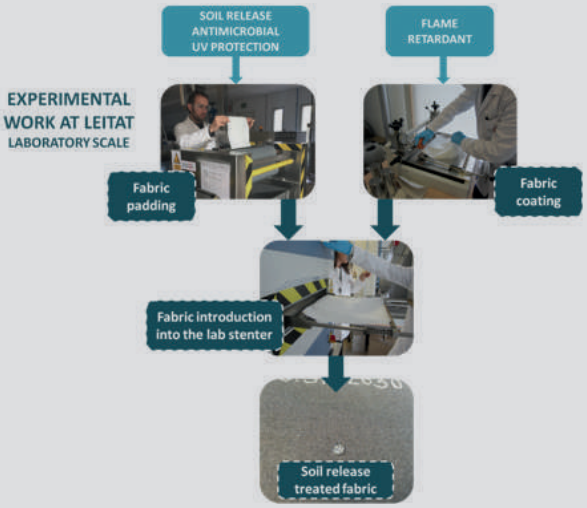


LUXURY GARMENT FABRICS

3 functionalities:
- Soil-release
- Antimicrobial
- UV-Protection

PROCESSES TRIALS AT LABORATORY SCALE

Preliminary trials have been done at LEITAT at laboratory scale in order to adjust the processes parameters and the formulations before the industrial application. Different percentages of formulation components have been tested, and also different process speeds, padding pressures and coating thickness.

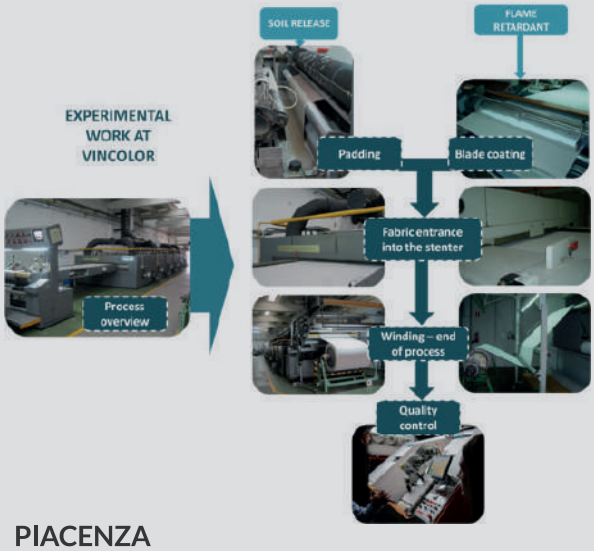


PILOT SCALE TRIALS AT INDUSTRIES:

The pilot scale trials were successfully performed at VINCOLOR and PIACENZA.

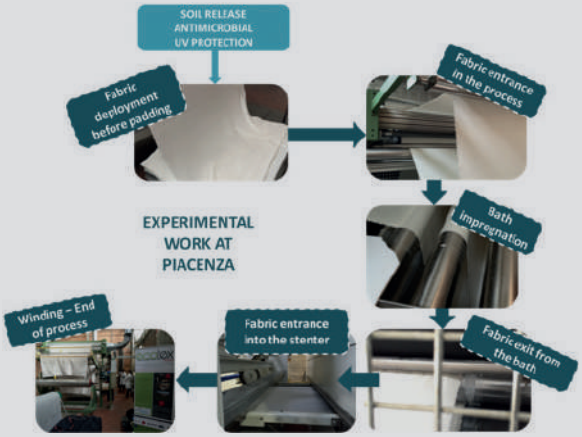
VINCOLOR

The company VINCOLOR (located in Terrassa, Spain) was responsible of performing the soil-release and flame retardant trials on upholstery fabrics, by padding and blade-coating techniques, respectively. During the process, the fabric is immersed in (padding) or coated with (blade coating) the formulation containing the soil release or flame retardant property. Then, heat is applied to dry the fabric and fix the finishing onto its surface. At the end of the process, the fabric is collected on a beam before going to quality control.



PIACENZA

The company PIACENZA (located in Pollone, Italy) was responsible of performing the soil-release, antimicrobial and UV protection trials on luxury garment fabrics, by padding technique. During the process, the textile is immersed into the bath containing the finishing agent. Then, the fabric is dried and cured under temperature. Finally, it is collected on a beam before going to quality control.

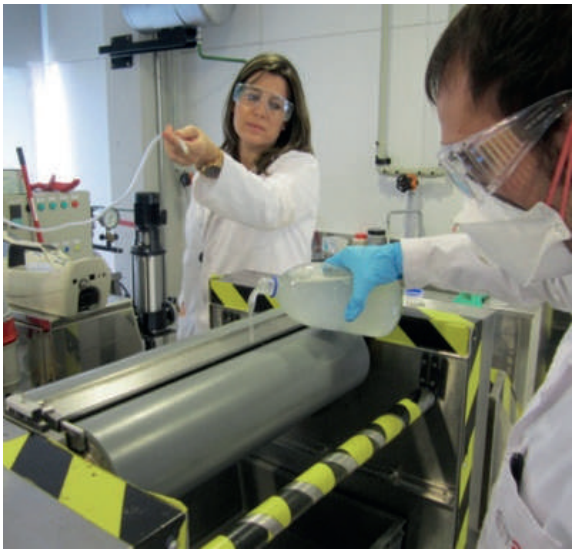


DEFINITION OF RISK MITIGATION STRATEGIES

Risk assessment has enabled to identify a number of strategies for the selection and use of adequate measures to control the risk posed by the use of nanomaterials.

- Avoid manipulating nanomaterials in a free particle state (i.e. dry nanopowders);
- Use good laboratory/ workplace practices, including the provision of adequate information and training for workers, and the use of adequate containers to store nanomaterials.
- Apply and design adequate administrative controls, including proper labeling and storage, implementation of cleaning and maintenance procedures, and limitation of the duration of the tasks and/or process involving the use of nanomaterials.
- Use properly designed LEV systems for conducting processes that cannot fit in a common partial enclosures suitable for handling particulate materials, such as fume cupboards or containment cabinets.
- Use PPE when engineering and/or administrative controls are not feasible or effective in reducing exposures to acceptable levels. PPE can include respirators, gloves, clothing, face shields, safety glasses, and other garments designed to protect the wearer.

An adequate protection of the human health and the environment can be achieved by means of the combination of administrative controls, engineering controls and personal protective equipment.



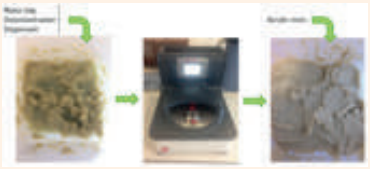
PROJECT OUTPUTS

The results of the ECOTEXNANO project are:

- Report on proposal for updating the Reference Document on Best Available Techniques (BREF) for the Textiles Industry (current TXT BREF from July 2003).
- Report on proposal for updating REACH Regulation (Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals).
- Report on proposal for updating other EU policies:
  - Regulation (EU) No 528/2012 concerning the making available on the market and use of biocidal products.
  - Regulation (EC) No 1272/2008 on classification, labeling and packaging of substances and mixtures (CLP).
- Innovative tool that improves the knowledge on risk assessment of nanomaterials and promotes the safe use along their life cycle. It allows calculating the environmental, health and safety impacts of a future textile.

REPORT ON PROPOSAL FOR UPDATING THE REFERENCE DOCUMENT ON BEST AVAILABLE TECHNIQUES (BATS) FOR THE TEXTILES INDUSTRY

The recommendations outlined are related to flame retardants and UV protection.

Topic	Recommendation
UV protection	Inclusion of this functionality among the chemical finishing treatments listed in the BREF.
Flame retardants	Need of further work that could continue the progress made testing this nanomaterial for this specific textile application. Nano-clay did not disperse in water, and a Planetary Ball Milling was needed to achieve a good dispersion. One of the challenges to be solved by finishing formulators is to improve the washing fastness of nano-based flame retardant finishing. 
Soil release	No recommendations. The technique and chemicals used for this functionality are already included in current BREF.
Antimicrobial	No recommendations Silver substances are commonly used as active substances but from the risk assessment performed during the project, it has been concluded that finishing containing Silver salts must be handled with some precautions.
Nanomaterials	Need of further experiments with nanomaterials that could serve for modelling their environmental performance and fate

REPORT ON PROPOSAL FOR UPDATING REACH REGULATION

Topic
"Nanomaterial" definition
Registration obligations
Notification obligations
Labelling obligations
Physicochemical endpoints
Specific surface area
Particle size and particle size distribution
Surface chemistry
Agglomeration and aggregation
Crystalline phase
Shape and aspect ratio
Ecotoxicity endpoints
Grouping proposals
New in silico methodologies (nano-QSAR) exposure /hazard modelling
Mapping of uses specific for textiles

	Recommendation
	Establishment of a worldwide accepted definition of “nanomaterial” including range of size, size distribution as well as surface area and include inorganic but also organic nanomaterials.
	Registration obligation of nanomaterials independently of the amount manufactured/imported.
	Notification obligations when using nanomaterials as well as labelling its presence in the final textile article
	Establishment of the obligation of labelling nanomaterials in textiles in order to indicate its presence.
	In addition to the standard data requirements for physicochemical properties, some further properties to be routinely considered for nanomaterials to be included in the CSA as an obligation in order to adequate characterize the nanomaterial for (regulatory) safety assessment: Specific surface area / Photo-catalytic properties Particle size and particle size distribution / Porosity and pour density Surface chemistry / Dustiness Agglomeration and aggregation / Dispersibility Crystalline phase / Zeta potential Shape and aspect ratio / Reactivity (redox potential, radical formation)
	Photo-catalytic properties
	Porosity and pour density
	Dustiness
	Dispersibility
	Zeta potential
	Reactivity (redox potential, radical formation)
	New/adaptation of (eco) toxicological endpoints in the CSA are needed in order to predict a correct DNEL and/or PNEC. Development of models predicting the toxicity of nanomaterials is still needed. It is needed the establishment of consensus among testing dose and exposure measurements units.
	Grouping of nanoforms based on the physicochemical behaviour or in the results from in vitro screening methods in order to reduce testing while still meeting the REACH data requirements to ensure the safe use of chemicals . Annex XI, Section 1.5 of REACH sets the conditions/criteria for using grouping and read across approaches to fulfil the information requirements for substances. If the read-across approach is
	New validated approaches for calculation of predicted level of exposure for worker, environment and consumer exposed to nanomaterials are still needed.
	New Product Categories (PROCs) and new Environmental Release Categories (ERCs) adapted to the particular characteristics of nanomaterials and specific for textiles are needed.

REPORT ON PROPOSAL FOR UPDATING OTHER EU POLICIES

Regulation No (EU) 528/2012 concerning the making available on the market and use of biocidal products	• Development and validation of methods for detection, characterization and analysis of nanomaterials that can be used within the framework of both the REACH- and the BPR-regulation. • Development of uniform guidance documents concerning the risk assessment of nanomaterials. • Development of a uniform methodology / approach for the classification of nanomaterials within the framework of the REACH- & BPR-Regulation.

Regulation (EC) No 1272/2008 on classification, labeling and packaging of substances and mixtures (CLP)	• Specific obligations to manufacturers and importers to notify all nanomaterials placed on the market on their own, in mixtures or in textile articles.
	• Notification obligations when using nanomaterials, as well as, REACH registration for amounts less than 1 tonne per year, are solutions that would permit and inventory of existing nanomaterials and their uses, improving the information in the supply chain.
	• Specific requirements of labelling of textile products that include nanomaterials.
	• Specific obligations for the labelling of nanomaterials in the textiles are proposed in order to indicate the presence of nano-sized ingredients in the finished article, regardless of their risk.
	• Specific requirements of the regulation of nanomaterials under REACH. Taking into account the plurality of physico-chemical characteristics and resulting changes in the hazard profile, an approach must be found to adequately cover nanomaterials. Accordingly, REACH information requirements have to be adapted. This includes:
	  • Lower tonnage thresholds for different REACH obligations (e.g. registration and chemical safety report) which are justified by highly dispersed use linked with the uncertainties regarding (eco)-toxicity, environmental fate and exposure.
	  • If the physico-chemical characteristics of different nanoforms of the same substance differ in a relevant manner they have to be considered separately for further test performance and REACH requirements. Thus, a separate classification and labeling may be required for the same substance.
	• Specific recommendation on the definition of a nanomaterial should be used in CLP regulation.
	• Establishment of validated methods and instrumentation for detection, characterization and analysis, completing information on nanomaterial hazards and developing methods to assess exposure to nanomaterials.
	• Development of CLP guidances documents and implementation tools in order to cover nanomaterials more specifically.
	• Additional testing requirements relating to physical hazards to be performed (e.g. physical condition, particle size (including nanomaterials) and shape (form), specific surface area, density, crystal structure).

ONLINE ECOTEXNANO TOOL

Available at: **http://itene-ecotexnano.nunsys.net/**
A major outcome of ECOTEXNANO is the online tool. It is an innovative tool that aims to improve the knowledge on risk assessment of nanomaterials and to promote the safe use in the finishing of textiles. It allows calculating the environmental, health and safety impacts of a future textile improving its environmental performance before being produced starting in the phase of design.

MODULES OF THE TOOL

RISK ASSESSMENT

To support the calculation of the levels of exposure to nanomaterials in occupational environments (occupational risk assessment) and the prediction of the number of substance released in the environment (environmental risk assessment) from a specific process involving nanomaterials as such, in mixture or as a part of articles.

ENVIRONMENTAL INDICATORS EVALUATION

Includes four environmental indicators: Carbon footprint (g CO2 eq.), Waste production (g), Water consumption (L) and Energy consumption (MJ).

KNOWLEDGE SHARING SPACE

To support the exchange of information on issues concerning the environmental, health and safety (EHS) assessment of nanomaterials used in textile industry.

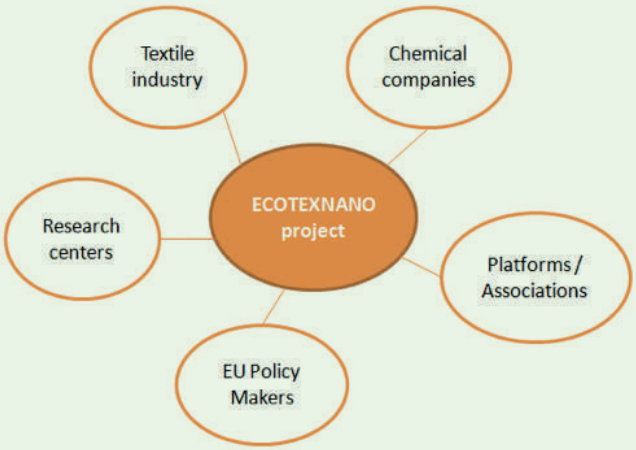
ECOTEXNANO CONTRIBUTES TO A SAFE USE OF CHEMICALS, AS WELL AS THE PROMOTION OF BEST AVAILABLE TECHNIQUES (BATS) AND RISK MANAGEMENT MEASURES (RMMS) ACROSS TEXTILES INDUSTRY.

CONCLUSIONS

ENVIRONMENTAL BENEFITS

The EU environmental policy requires companies to be increasingly aware on their main environmental concerns, and linked to their economic and social aspects. Sustainable production is strongly pursued and companies claim tools that facilitate them management of these regulatory schemes.
In the project, the fact that a finishing application is either conventional-based or nano-based has not demonstrated differences in the manufacturing conditions in terms of consumables other than chemicals.
Besides, although measured concentrations of particles in both case studies are generally quite high, there are no significant differences between the application of the conventional product and nanocomponent respect to the background measurement, appreciating a relatively low risk in both environmental and occupational exposure scenarios.
This means that every type of treatment must be individually assessed depending on the type of chemicals and other resources used, and it has been demonstrated that other environmental indicators related to the manufacturing process, such as energy consumption or water depletion, do not differ between both conventional and nano-based treatment when both types of treatments are applied with the same technology/machinery and for a same textile property.
The project outputs are not oriented to suggest potential replacement of conventional by nano-based technologies, but they are aimed to increase the knowledge of the textile industry on environmental care and safe use of the chemicals they use in their finishing applications, and more exhaustively related to nanomaterials due to the existing concern on their release to the working scenarios and to the environment.
The ECOTEXNANO tool offers a database with a wide range of chemicals by each textile property, which facilitates EU textile industry managing data on intrinsic and hazard properties of relevant materials, and helping them in their selection of chemicals.
Moreover, a set of 40 environmental RMMs are compiled by each of the working scenarios identified in the finishing of textiles, and most of them are aimed to minimize impact on atmosphere emissions while around a 30% of measures are aimed to the water emissions control at industry. Users may estimate their exposure depending on the operative conditions and applied risk management measures.

SOCIOECONOMIC IMPACTS



More and more companies incorporate social accountability in their management. The globalization of textile market causes that social requirements have to be considered in the supply chain. Many textile companies have had to fend off accusation related to human rights. For example, the public scandal about "sandblasting" caused social impact and some companies had expressed publicly that agree to eliminate this technique. All these aspects are important to ensure human rights in the production chain and avoid negative social impacts. Health and safety potential risks posed by the use of nanomaterials on workers due to handling and application of nanomaterials in finishing processes of textiles have been assessed throughout the project.

Considering the project aims and the project outputs, the socio-economic impacts that have been identified for each stakeholder are summarized in the following table:

STAKEHOLDER	EXPECTED IMPACT
TEXTILE INDUSTRY	• Provides a Tool that allow companies to know about risk assessment and the environmental performance of their finishing textile processes • Increases the knowledge on the environmental impact of the finishing of textiles • Increases the knowledge on the risk assessment and the application of risk management measures in the finishing textile scenarios • Availability of a tool for the decision-making process in the environmental management.
CHEMICAL COMPANIES	• Provides a Tool that allow companies to know about risk impact assessment and the safe use of nanomaterials • Increases the knowledge on the environmental impact of the chemicals involved
PLATFORMS/ ASSOCIATIONS	• Increases the quality of the services that they offer
RESEARCH CENTERS	• Increases sales of its sustainable tecnologies or measures • Job creation • Sustainability as an added value of its products (Technology, services,...)
EU POLICY MAKERS	• Policy recommendations for potential update of REACH, CLP, biocides regulations • BAT candidate for potential update of the BREF for Textiles Industry • Availability of a tool to promote the safe use of nanomaterials in textile finishing

Particular information regarding the use of nanomaterials in the textile industry has been obtained from specific surveys carried out in the framework of the project. Based on the information extracted from undertaken questionnaires, only a 20% of surveyed companies use nanomaterials, and only a 20% still don´t know what a nanomaterial is. The increase on knowledge on properties of nanomaterials and their possibilities for improving textile products is highly needed as approximately a 20% of surveyed companies are not aware of the improvements nanomaterials can introduce in textile industry and other 20 % are still reticent for using them because the existing lack of knowledge on their hazards.
The following table represents how the project contributes to increase social awareness on the human, safety and environmental impacts of the textile sector using nanomaterials.

Sub-indicator	Average improve-ment
Improvement in air risk management measures (RMM)	30 %
Improvement in water RMM	60 %
Improvement in the number of RMM at industry level	60 %
Improvement in the risk characteri - zation ratios (RCR) due to the RMM implemented thanks to the ECO - TEXNANO Tool for each scenario considered	76 %
Improvement in the environmental RCRs for the water compartment after the implementation of the rec-ommended RMM (pilot scale)	56 %
Improvement in the environmental RCRs for the water compartment after the implementation of the rec-ommended RMMs (industrial scale)	63 %

DISSEMINATION OF THE PROJECT ACTIVITIES

The objectives and outputs of the project have been presented in many conferences, scientific events, workshops and press media.

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