FINAL REPORT TEMPLATE

FRONT PAGE

PROJECT FINAL REPORT

"**Publishable**"

Grant Agreement number: 222486

Project acronym: FRONT

Project title: Flame Retardant ON Textile

Funding Scheme: Collaborative Project targeted to special groups such as SMEs and other smaller actors

Period covered: from 1st November 2008 to 30th April 2011

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Project website[1] address: www.projectfront.eu

1. FINAL PUBLISHABLE SUMMARY REPORT

[1] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm ; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

This is a comprehensive summary of results, conclusions and the socio-economic impacts of the project. The publishable report shall be formatted to be printed as a stand alone paper document. This report should address a wide audience, including the general public.

Please ensure that it:

- *Is of suitable quality to enable direct publication by the Commission.*
- *Is comprehensive, and describes the work carried out to achieve the project's objectives; the main results, conclusions and their potential impact and use (including the socio-economic impact and the wider societal implications of the project). Please mention any target groups such as policy makers or civil society for whom the research could be relevant.*
- *Includes where appropriate, diagrams or photographs and the project logo, illustrating and promoting the work of the project.*
- *Provides the following information:*
    - *List of all beneficiaries with the corresponding contact name and associated coordinates*
    - *The address of the public Website of the Project as well as relevant contact details.*

The main objective of FRONT project, taking advantage of nanotechnologies, was to obtain textile fabrics with flame retardant properties in order to have optimal properties durable in time and to be used in different field of applications (protective garments, furniture upholstery bed linen).

FRONT purpose was to introduce finishing products, based on NPs, in European textile market, to produce textile fabrics resistant to fire with high performance and quality, as requested from evolution of legislation and from customer attention.
Current market solutions for Flame Retardant (FR) effect present several criticalities:

- Cotton (COT): the use of chemical products in finishing (the only technical possibility at the moment) is not completely compatible with international standards on health and safety;
- man made fibers (particularly Polyester, PET): current processes consent to create FR fibers used for specific aims (i.e. firefighters bunker gears, workers uniform, racing uniform etc). The intrinsically FR fibers have a high cost; fibers present rigidity, a huge problem for storage and, above all, for use in clothing manufacture. Moreover, during combustion PET creates burning drops.
- Blended fibers: usually they present a flammability that is worse than that of either component alone.
- Toxic smokes: current anti-flame treatment do not face properly the release of a high quantity of toxic smokes during combustion and the environmental impact of products themselves.

For this purpose, textile fabrics of interest for companies involved in the project have been selected and characterized in the first phase of project activities. Each industrial partner (IND) selected textile substrates specific for its own market sector, to be characterized. Substrates were divided into two main groups:

- **Reference flame retardant fabrics**. They represented the state of the art for flame retardant properties produced by the IND partners and served to set-up the objective of the project.
- **Reference fabrics for trials.** They were not flame retardant fabrics but standard fabrics ready to receive the nanoparticles (NPs), in order to evaluate the effects of the innovative treatments.

Textile substrates were planned as different blends, without the exclusion of neat substrates, of polyester and cotton, considering their diffusion and the substantially low cost.
During project activities implementation, research and tests were focused on neat polyester and blend fabrics as for neat cotton fabrics first results were not encouraging. In any case, cotton fabrics first test results are part of project report as they give know-how and knowledge useful for understanding the issue.

Research activity focused then on the identification and selection of NPs able to give flame retardant properties to textile fabrics during finishing step. Different aspects were taken in consideration, such as, for example, size and shape, non-toxicity, non-halogenated content, solubility in aqueous media, potential flame retardant properties. Another important theme considered has been the availability on the market, as it was essential to find out results with NPs easy to find and with a cost affordable for a future market exploitation.
A detailed selection of NPs has been carried out by Politecnico di Torino research group involved, on the basis of experience developed through the participation to research projects about the use of nanoparticles as flame retardant additives in polymer matrices via melt blending.
Selected nanoparticles have been characterized (morphological, structural, chemical and thermal point of view) and a lab-scale approach was optimized in order to mimic the finishing industrial treatment and furthermore to obtain prototypes to test in terms of combustion behavior. Finally, optimal conditions to obtain the highest adhesion of nanoparticles on the textiles have been defined.
Activities performed leaded to find out a series of 5 NPs resulting the most promising fillers as flame retardant additives for polyester matrix. Through cone calorimetry measurement it has been demonstrated that the presence of these nanofillers change the combustion behavior of the neat textile. Important parameters such as time to ignition (TTI), peak of heat release rate (pkHRR), total smoke release (TSR) and optical density of smokes (SEA) are modified.
The great advantage of this approach is the addition of low amounts of nanoparticle used in comparison with the traditional/commercial flame retardants, that was one of main project objectives.
One of the 5 NPs selected has been submitted to an industrial approach with the collaboration between Politecnico di Torino and Europizzi S.p.A. introducing commercial elements in order to ameliorate the nanoparticle dispersion and stability.
Moreover, in order to improve the durability properties in the time, the use of commercial crosslinkers was applied. One of possible risks pointed out in project preparation phase was the scarce adhesion of nanoparticles on the textiles. For this reason, two different approaches has been tested only on laboratory scale: a first one based on a pretreatment of the surface textile by etching (plasma technology) and a second one, based on the formation of a coating (sol-gel process). The two approaches haven't been prosecuted in subsequent trials.
As concerning benefits for citizens, results provided by FRONT will reduce the **risk of fires** increasing overall health conditions and quality of life in the EU.

The aim of FRONT was also to look for new technologies and/or approaches to improve EU citizens health and quality of life and to reduce the use of toxic substances and effluent

emission and to comply to the directive on Integrated Pollution Prevention and Control (IPPC) and REACH) directed to encourage a sound environmental approach to industrial waste problems.
The contribution of the project to preserving and/or **enhancing the environment** and natural resources will be mainly due to the reduced quantity of chemical products which will have to be used in the finishing treatment, and the emission of toxic waste in the effluent water again contributing indirectly to citizen's health.
The avoidance of use of noxious chemicals will substantially **improve working conditions**.
FRONT will play a role in contributing to sustainable development through reduction of material content of products whilst increasing their service value, and through innovative, safer, cleaner and low resource intensity processes. Also new methods of organising production will, through the project, reduce costs.

Resources invested during FRONT Project were not sufficient to solve all the problems concerning FR products and the technological transfer from plastics sector to textile sector concerning the use and the behaviour of nanoparticles. It is possible, anyway, to underline the results gained thanks to the efforts of partners involved in the projects. As an example, the compounding recipes used by Europizzi could be improved and could be basis of new formulates and products. As a second example, industrial partners could define new definitive industrial processes to be applied to create new products.

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