COST

Domain Committee " MPNS "

COST Action *MP1105*

Start Date 23/05/2012

Sustainable flame retardancy for textiles and related materials based on nanoparticles substituting conventional chemicals (FLARETEX)

MONITORING PROGRESS REPORT

Reporting Period: *from 23/05/2012 to 01/06/2013*

This Report is presented to the relevant Domain Committee.
It contains three parts:

I. Management Report *prepared by the COST Office/Grant Holder*
II. Scientific Report *prepared by the Chair of the Management Committee of the Action*
III. Previous versions of the Scientific Report*; i.e., part II of past reporting periods*

The report is a "cumulative" report, i.e. it is updated annually and covers the entire period of the Action.

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter *II.D. Self evaluation*.

Based on the monitoring results, the COST Office will decide on the following year's budget allocation.

Executive summary (max.250 words):

The aim of the COST Action MP1105-FLARETEX is to form a European multidisciplinary Knowledge Platform on Sustainable Flame Retardancy to facilitate the rapid development of fire safe textiles and related materials of low toxicity and ecotoxicity, using all the available/novel technologies. At present the Action comprises 23 signatory COST countries and 1 non-COST member. During the 1st year 8 events were organised : kick-off meeting, one MC meeting, one Steering Group meeting, one cohesive meeting of all WGs, one industrial workshop, two scientific workshops and one joint workshop with another COST Action (MP1206). In total 189 individual participants from various fields were involved in these events. The industrial workshop was focused on "Flame retardant functionalisation of textiles in industrial wet-chemical processes" and half of the speakers and participants were from industry, so the research-industry collaboration was successfully enhanced. All workshops had a very high scientific level and attracted a large number of participants, including many ESRs. In the workshop on "Innovative Flame Retardant Systems (applications and testing)" the current state-of-the-art was presented and the workshop on "Nanoparticles for flame retardancy: challenges and risks" introduced the role and potential of nanoparticles for efficient flame retardancy whereas also potential ecotoxicological risks were discussed. 7 STSMs were concluded establishing new collaborations between member institutes. Remarkable scientific outputs developed within the consortium are related to the use of natural and hybrid nanoparticles for flame retardancy and the use of DNA from herring sperm as an efficient green flame suppressant and retardant for cotton fabrics.

I. Management Report prepared by the COST Office/Grant Holder

I.A. COST Action Fact Sheet

- **COST Action** *MP1105 – FLARETEX*
-
- **Domain** *MPNS*

- **Action details:**

CSO Approval: *01/12/2011* **End date:** *22/05/2016*
Entry into force: *06/01/2012* **Extension:** -

- **Objectives**

Replacement of existing flame retardants (FR) with sustainable and environmentally friendly alternatives for textiles in domestic, safety, transport (automotive, rail, aerospace and marine), civil emergency and military, construction and other industries requires a multidisciplinary approach from textile technology to the physics and chemistry of fire. This COST Action will create an international multidisciplinary scientific and technology network on Sustainable Flame Retardancy, developing new innovative flame retardants with low fire toxicity and environmental impacts and halogen-free. A COST Action is ideal to promote the existing cooperation in flame retardancy research, in order to accelerate growth to keep Europe leading the world in this crucial area, taking into account sustainability, safety and health, and to facilitate its commercial exploitation in Europe.

- **Parties:** *list of countries and date of acceptance: 23*

Austria 14/12/2011	**Greece 14/02/2012**	**Poland 18/01/2012**
Belgium 20/01/2012	Hungary *(date)*	**Portugal 06/01/2012**
Bulgaria 21/08/2012	Iceland *(date)*	**Romania 18/10/2012**
Croatia 29/12/2011	Ireland *(date)*	Serbia *(date)*
Cyprus *(date)*	Israel *(date)*	**Slovakia 23/03/2012**
Czech Rep. 27/03/2012	**Italy 13/01/2012**	**Slovenia 05/01/2012**
Denmark 20/01/2012	Latvia *(date)*	**Spain 09/01/2012**
Estonia *(date)*	**Lithuania 20/03/2012**	**Sweden 20/02/2012**
Finland 26/01/2012	Luxembourg *(date)*	**Switzerland 24/01/2012**
FYR of Macedonia *(date)*	Malta *(date)*	**Turkey 11/05/2012**
France 10/02/2012	**Netherlands 17/01/2012**	**UK 06/12/2011**
Germany 18/01/2012	Norway *(date)*	

- **Intentions to accept:** *0*

- **Other participants:**
Council for Scientific and Industrial Research, South Africa, Port Elizabeth

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- **Action Web site:** *http://www.flaretex.eu*
- **Grant Holder Representative:** *Els Van der Burght, els.vanderburght@UGent.be*
- **Working Groups** *(list of WGs and names and affiliations of participants)*

WG1 - Novel Flame Retardants		
Name	**Organisation**	**Country**
WG-Leader: **Prof. Francesco Branda** **Dr. Giulio Malucelli**	**University "Federico II Napoli** **Politecnico di Torino**	**Italy**
Mr. Xavier Almeras	DEVAN	Belgium
Dr. Jenny Alongi	Politecnico di Torino	Italy
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Dr. Mathilde Casetta	Ecole Nationale Supérieure de Chimie de Lille (ENSCL)	France
Dr. Paul Cusack	ITRI Ltd	UK
Dr. Paulo Fernando Martins de Magalhães Correia	FISIPE	Portugal
Dr. Pilar Diaz	AIDICO	Spain
Mr. Maxence Dubus	DEVAN Chemicals	Belgium
Prof. Sophie Duquesne	Ecole Nationale Supérieure de Chimie de Lille (ENSCL)	France
Mr. Frans Dutrieue	Fire Retardant Innovators	Belgium
Dr. Ing. Victoria Dutschk	University of Twente	Netherlands
Mr. Enrico Fatarella	Next Technology Tecnotessile (NTT)	Italy
Dr. Laurent Ferry	Ecole des Mines d'Alès	France
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Mrs. Weronika Gieparda	Institute of Natural Fibres and Medicinal Plants	Poland
Mr. Sieghard Goebelbecker	ICL-IP Europe B.V.	Netherlands
Prof. Ana Marija Grancaric	University of Zagreb	Croatia
Prof. Dr. Thomas Graule	EMPA	Switzerland
Ass. Prof. Evgeni Hristov Ivanov	Bulgarian Academy of Sciences	Bulgaria
Prof. Baljinder Kandola	University of Bolton	UK
Dr. Ralf Kappes	Deutsches Textilforschungszentrum Nord-West GmbH	Germany
Dr. Erich Kny	KEMYK	Austria
Prof. Joseph H. Koo	The University of Texas at Austin	USA
Dr. Claudio Larosa	University of Genoa	Italy
Dr. Jan Marek	INOTEX spol. s r.o.	Czech Republic

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Dr. Giuseppe Rosace	Università di Bergamo	Italy
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Dr. Rodolphe Sonnier	Ecole des Mines d'Alès	France
Dr. Pascal Steffanut	CLARIANT	Switzerland
Dr. Timea Stelzig	EMPA	Switzerland
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WG2 - Toxicological/environmental aspects		
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WG-Leader: **Dr. Anna Stec**	**University of Central Lancashire**	**UK**
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I.C. Overview activities and expenditure

1st year Budget

Total Action Budget **185226,42 EUR**

Remaining Action Committment **21447,22 EUR**

Meetings

Meeting Type	Date	Place	Paid participants	Cost	Status	Total
Kick-off	23.05.2012	Brussels (BE)	25	15726,42	Paid	
1st Steering Group meeting	12.11.2012	Paris-Est, France	10	6224,79	Paid	
1st scientific meeting of all 4 WG's	13.11.2012	Paris-Est, France	24	16026,82	Paid	
2nd Management Committee meeting	15.05.2013	Krakow, Poland	23	21666,54	Partially paid	
Total						**59644,57**

STSM

Beneficiary	Date	From	To	Cost	Status	Total
Ms Piyanuch Luangtriratana	1.02-30.04.2013	Bolton University, UK	École Nationale Supérieure de Chimie de Lille, FR	2.500	Paid	
Dr Jenny Alongi	1.03-30.04.2013	Politecnico di Torino, IT	Bolton University, UK	2.500	Paid	
Dr Federico Carosio	11.03-30.04.2013	Politecnico di Torino, IT	Institut Charles Sadron,FR	2.500	Paid	
Ms Marta Martins	1.04-19.04.2013	INEGI, PT	Fraunhofer-Institut für Keramische Technologien und Systeme, DE	2.110	Paid	
Ms Mirella Vaxevanidi	1.04-10.05.2013	Technological Educational Institute of Piraeus, EL	Ghent University, BE	1.200	Paid	
Mr Marcos Batistella	2.04-18.04.2013	Ecole des Mines d`Ales, FR	University of Trento, IT	1.830	Paid	
Dr Claudio Larosa	5.04-23.04.2013	University of Genoa, IT	University of Twente, NL	2.010	Paid	
Total						**14.650**

Workshops

Title	Date	Place	Paid participants	Cost	Status	Total
Industrial workshop on "Flame retardant functionalization of textiles in industrial wet-chemical processes"	5.10.2012	University of Twente, The Netherlands	10	6670,19	Paid	
Scientific workshop on "Innovative Flame Retardant Systems (applications and testing)"	27-28.03.2013	University of Maribor, Slovenia	31	27244,04	Partially paid	
Scientific COST MP1105 workshop on "Nanoparticles for flame retardancy : challenges and risks" within MPM2013 Polymer conference	16.05.2013	Cracow University of Technology, Poland	18	13253,61	Partially paid	
Scientific COST MP1105 workshop on "Electrospun Nano-fibres for bio inspired composite materials and innovative industrial applications in textiles" within 2BFUNTEX conference (in cooperation with COST MP1206)	30-31.05.2013	Istanbul Technical University, Turkey	20	19505,56	Partially paid	
Total						**66673,4**

General Support Grants

Title	Date			Cost	Status	Total
						0

Schools

Type	Date	Place	title	Cost	Status	Total
						0

Honoraria

Title	Date	Expert		Cost	Status	Total
						0

Grant

Grant Holder	Date			Cost	Status	Total
Ghent University				19311,23		**19311,23**

Dissemination

Title	Date			Cost	Status	Total
Development COST MP1105 FLARETEX website + dissemination materials	3.04.2013	Paris-Est Créteil University, France		2.500	Paid	
Conference Book COST MP1105 workshop on Nanoparticles for flame retardancy : challenges and risks		Cracow University of Technology, Poland		1.000	Paid	
Total						**3500**

Action Total 163779,2

II. Scientific Report *prepared by the Chair of the Management Committee of the Action, describing results achieved during the Action operation in this period, in no more than 3 pages (the report is "cumulative"). All items listed in Sections A, B, and C, below, must be addressed.*

Additional documentation such as extended scientific reports, proceedings of workshops, seminars or conferences may be provided separately as an annex to this report, and should be referenced in the report.

II.A. Innovative networking

- *Innovative knowledge resulting from COST networking through the Action. (Specific examples of Results vs. Objectives)*

During the 1st year of the Action the following results vs. objectives were achieved :

Objective A : Identification of the safer alternative to halogenated and antimony based FRs.

Result 1 : Identification of polyphosphazenes as new non-halogenated FRs for textile finishing.

Result 2 : Identification of "sol-gel" based systems - derived from nitrogen as well as phosphor based alkoxysilans - as non-halogenated flame retardants for durable textile finishing.

Result 3 : Use of zeolites and silicon based organic compounds on cotton to improve the flame retardancy.

Objective B : Development of new and sustainable nanobased FR systems for application in textile and related materials

Result 1 : Development of nanosols containing non-halogenated precursors, employed as finishings yielding flame retardancy.

Result 2 : Thin coatings of functionalised nanoclays have been successfully deposited on the surfaces of glass fibre-reinforced epoxy composites using and atmospheric pressure plasma or a resin binder. The coatings have shown good thermal barrier properties.

Result 3 : The use of deoxyribonucleic acid (DNA) from herring sperm as a natural intumescent flame retardant on cotton textiles has been explored.

Result 4 : Development of FRs containing nanoclay nanoparticles for coating and specific formulations for masterbatch applications – fibre modification.

Result 5 : Hydrothermal synthesis of oxide nanopowders. Examples of nanopowders with potential applications in FRs: ZrO_2, TiO_2, Ag-doped ZnO, layered double hydroxide (LDHs) nanoparticles

Objective C: Analysis of their effectiveness, durability, (smoke) toxicity and particularly environmental impact (LCA).

Result 1 : Establishment of the unique Large Instrumented Fire Enclosure Facility (LIFE) for investigation of large scale fire behaviour of new and sustainable nanobased FR systems for different applications.

Result 2 : Toxicity testing of fire effluents — Guidance for analysis of gases and vapours in fire effluents using FTIR gas analysis.

Objective D: Improved surface treatment and application processes for FR.

Result 1 : Novel and efficient silica and/or alumina or phosphorous-based FR systems have been developed. To this aim, "sol-gel" treatments and "layer-by-layer" assemblies have been exploited.

Result 2 : Functionalisation of oxide colloidal nanoparticles by spray-drying micro-encapsulation processes. Examples: Ag-doped ZnO micro-encapsulated with polymethyl methacrylate (PMMA).

Result 3 : Atmospheric plasma has been successfully used to activate textile and textile composite surfaces prior to nanoclay deposition.

Result 4 : Use of "sol-gel" and "layer-by-layer" techniques to coat the surface of textiles. Very recently sol-gel technique has also been used to deposit silica on the surface of glass fibre-reinforced composites.

Result 5 : Use of UV lamp technology (excimer UV lamps and broadband lamps) for the durable immobilisation of phosphorus-based flame retardants.

Objective E : Study of the synergistic effect of combining nanomaterials with conventional FRs.

Result 1 : Sol-gel derived silica nanoparticles have been successfully combined with conventional phosphorous-based FRs.

Result 2 : Studies of synergy (boasting x risk of FR drop) in combination with multifunctional finishing (water x oil repellence, breathable coatings), influence on the mechanical-physical properties (durability, physiological comfort).

Objective F : Characterisation, safety aspects, quality assurance, property database.

Result 1 : DSC-TG characterisation of nanoparticles and coatings;

Result 2 : Chemical analysis of oxide nanoparticles by inductive plasma coupled optical emission spectrometry (ICP-OES).

Result 3 : Grain size and zetapotential measurement of oxide nanoparticles stability of colloidal particles in solutions as a new method for characterisation of safety aspects.

Objective G : Scaling up and commercialisation.

Result 1 : New formulations of FR products - small scale-up finishing capacity (impregnation, coating).

- *Significant scientific breakthroughs as part of the COST Action. (Specific examples)*

A. The use of nanoparticles for flame retardancy, including natural and hybrid nanoparticles

Examples : 1) Nanoclays or ceramic particles deposited on the surfaces of glass reinforced composites can act as effective thermal barriers. 2) Hydrothermal synthesis at high pressures and low temperatures of inorganic-organic hybrid nanopowders. The scientific breakthrough consists in modelling the high pressure interactions between organic ligands and inorganic particles.

B. Increased use of P-based flame retardants as alternative for halogen based FRs.

Examples : 1) Development of an UV-based process for the immobilisation of new non-halogenated flame retardant polyphosphazenes. 2) Development of new multifunctional precursors exhibiting nitrogen and phosphor groups – used for the preparation of flame retardant sol-gel finishings.

C. The use of natural (= green) flame retardants

Example : Deoxyribonucleic acid (DNA) from herring sperm can be used as an efficient green flame suppressant and retardant for cotton fabrics, due to its intrinsic intumescent features. To understand the mechanism of action and further improve its efficiency, an STSM has been carried out from Politecnico di Torino to Bolton University.

D. The use of layer-by-layer deposition and sol-gel technology

Example : The use of layer-by-layer deposition techniques has clearly demonstrated great potentialities as a novel “green” approach for conferring significant flame retardant features to cellulosic (i.e. cotton) or synthetic (polyester, …) fabrics.

E. The use of multifunctional (nano)chemicals combining flame retardancy with other properties, such as water and oil repellency, breathability, crease resistance, anti-microbial, …

F. Development of instrumental and computational tools for investigation of polymer nanocomposite flammability

- *Tangible medium term socio-economic impacts achieved or expected. (Specific examples)*

The expected socio-economic impacts of COST MP1105 Action are :

1) Development and use of new environment-friendly flame retardants eliminate risk of REACH significant barriers of use of halogenated/brominated systems.
2) Focus on durability (laundry maintenance) – non-direct environmental impact – prolongation of service life of added value textiles.

3) Flame retarding of textiles will influence significantly the health – safety and passive protection against injuries and significant economic losses. Specific conditions and concepts for automotive / transportation, construction, military etc. are studied.
4) Based on the knowledge gained in the meetings of the COST MP1105 the developed flame retardants can contribute to improvements in fire safety and limiting casualties and materials losses, as well as may gradually replace the commonly used toxic halogen flame retardants thereby helping to protect the environment (use of green FRs).

- *Spin off of new EC RTD Framework Programme proposals/projects. (List)*

COST MP1105 members are participating in the following EC projects :

- EU FP7 NMP (NMP.2012.1.3-1) "Development of safer and more Eco-friendly flame Retardant materials based on CNT co-additives for Commodity Applications" (DEROCA) – UK, BE, FR, SE, IT, DE, TR.
- MANUNET PROGRAM, Project title “Integrated manufacturing process for textile applications and wood protection” – Acronym MANUCOAT, period 2013-2014 – RO, ES.
- FP7-SME-2012-1 Research for SMEs. “Development of a new Bio-Composite from renewable resources with improved thermal and fire resistance for manufacturing truck internal parts” (NATURTRUCK).
- ERA-NET (CROSSTEXNET) : SUSFLE (“Sustainable Flameproof Fabrics for Technical Application”) – CZ, IT, ESP, TR
- E! 5799 BATAN “Barrier Textiles and Nanomaterials” – implementations of FR in special textiles (hospital, clean room PPE) – CZ, FIN, PL, UKR, SI, LAT
- The starting CORNET “LED UV Cure” project includes FR functional systems – environmental, energy efficiency – CZ, DE, BE
- SUSPUR, Eureka research project (21 months) to bring a new flame retardant technology to the market - CH, AT

Furthermore, the following 2 proposals have been submitted :

- German-Greece bilateral proposal on the use of graphenes as flame retardants on textiles (Acronym “GeTail”, submitted within the call of the German Federal Ministry of Education and Research for bilateral R&D cooperation, 2013 – 2015, projects for partnerships in science, research and education with Greece).
- ERAfrica - New Ideas (ERAFRICA_RE-008) : BIOFLAMTEC (Plant-inspired flame retardant technologies using a biomimetic approach). Partners: CSIR, PORT ELIZABETH, South Africa - Ecole Nationale Supérieure de Chimie de Lille (ENSCL), France - Universität Bayreuth, Germany - Kenyatta University, Nairobi, Kenya.

- *Spin off of new National Programme proposals/projects. (List)*

- MECTEX “Functional textiles for medical care and elderly people quality of life”, FR-TI3/466 (MPO CZ). Durable FR for hospital health care and elderly people population (home-care) - CZ.
- CLUTEX – technical textiles Cluster. Particular R&D project action “ECOFLAME“ focus on the environment-friendly FR alternatives for industry partner innovations - CZ
- National Partnership Project PN-II-PT-PCCA-2011-3.2-1368 Contract: 167 “Technologies for leathers with self-protection properties by surface modification with oxide and metal nanoparticles for advanced applications” - Acronym SELFPROPIEL, financed by UEFISCDI Romania. Participants: National Institute for Textiles and Leather Industry and National Institute for Nonferrous and Rare Metals, Romania.
- Applied Research Programme of the Polish National Centre for Research and Development. “New silicon-organic modification agents for natural fibres and fabrics”.
- OPUS General Grants of Polish National Science Centre. “The study of the phenomenon of synergism in reducing the flammability of the composites between modified natural fibres and halogen-free fire retardants”.
- Applied Research Programme of the Polish National Centre for Research and Development “Innovative materials limiting the fire threat in leaving and public buildings”.

II.B. Inter-disciplinary networking

- *Additional knowledge obtained from working with other disciplines within the COST framework. (Specific examples)*
  - New scientific protocols on intumescence characterisation were developed in the framework of STSM activities (Mission of Piyanuch Luangtriratana) - collaboration of ENSCL – France and the University of Bolton, UK.
  - The National R&D Institute for Nonferrous and Rare Metals, Romania, gained knowledge about the application of spray-drying method for micro-encapsulation of oxide colloidal nanoparticles.
  - The Faculty of Textile Technology of the University of Zagreb, Croatia, obtained knowledge about MCC (micro cone calorimeter) and all parameter details this instrument can perform and about a wide range of silicon-based compounds for potential use in flame retardancy.
  - During her STSM at Bolton, Dr. J. Alongi (Politecnico di Torino, IT) used her previous experience of sol-gel and layer-by-layer techniques for depositing nanoparticles on cotton textiles on fibre-reinforced composites.
  - Development of instrumental and computational tools for investigation of polymer flammability by UCLAN, UK, in cooperation with ENSCL, FR.
  - During the COST MP1105 workshop in Maribor a joint study of possible application of the original cationisation system of INOTEX (CZ), as a pre-activation for the layer-by-layer principle of textile FR was started with POLITO (IT). Samples of cationised fabrics (Co, PES) were tested by POLITO.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts. (Specific examples)*

Stronger cooperation between chemists, physicians, material science engineers and textile engineers will provide, of course, knowledge based technologies for FR nanosystems development and development of new characterisation methods.

For the SME INOTEX (CZ) the interdisciplinary networking within the COST Action plays an important role – by search for new impulses for technical innovations coming from the scientific area of the Action. INOTEX tries to transfer the new impulses into acceptable solutions for the industry. New possibilities of special analysis and testing are improved within the COST consortia.

Based on COST MP1105 partners instrumental and knowledge potential, it is very clear that the level of interdisciplinarity is very high. There are many material chemists in the group with well-equipped laboratories, partners with long experience in thermal behaviour of polymers and textiles, in field of toxicity, standardisation etc.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts. (Specific examples)*

Undoubtedly, gathering at the COST meetings specialists in flame retardants for various applications, as well as representatives from industry can result in developing more efficient environmentally friendly fire retardants which can improve safety and reduce the pollution.

Socio-economic dimension of research and innovation in the area of effective, cleaner production based (textile) flame retardancy in the area of health/safety (active, passive) protection (PPE, health care, transportation).

The main socio-economic potential is in the area of sustainable, cleaner-production based FRs. Compatibility of FR protection and safety with acceptable comfort (breathability, fabric softness/touch, moisture and thermal transport) are part of the Action – synergistic finishing systems and effects.

COST MP1105 partners are from universities, institutes and industry presenting a strong inter-disciplinary group convenient for providing the socio-economic impacts.

II.C. New networking

- *Additional new members joining the Action during its life.*

At the kick-off the Action comprised 21 COST countries. During the 1st year 2 more COST countries signed the MoU (Bulgaria and Romania) and one non-COST country (South Africa, Council for Scientific and Industrial Research) has been approved by the MC and JAF to join the Action, bringing the total to 24 participating countries.

- *Total number of individual participants involved in the Action work. (Number of participants. Give % of female and of Early Stage Researcher participants)*

During the 1st Action year **189 individual participants** were involved in the Action activities. From these **41% are female** (78) and **21% are Early Stage Researchers** (39).

- *Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools. In addition, justification should be provided if less than 4 STSMs were carried out during the year.*

7 STSM visits have been realised within the 1st Action year (see section I.C), all by Early Stage Researchers. Further, ESR have participated in all the networking activities : workshop Enschede (10% ESR), WG meeting Paris (7% ESR), workshop Maribor (20% ESR), workshop Krakow (20% ESR) and workshop Istanbul (27% ESR).
For the starting year of the Action no Training School was planned. The 1st Training School on "Flame Retardant Solutions for Fibre Reinforced Composites" will be organised in February 2014 in Porto, PT, and will be especially aimed at ESR.

- *Involvement of researchers from outside of COST Countries. (Number of participants from non-COST Countries approved by the CSO. Give % of such participants from countries with reciprocal agreements. Specify their contribution)*

During the 1st Action year 11 individual participants from non-COST countries have participated in the Action's activities : USA (4), Egypt (1), Hong Kong (1), Hungary (2), New Zealand (1), Rep. Argentina (1), Singapore (1),
In Spring 2013 two representatives of the Council for Scientific and Industrial Research of South Africa have been approved by the CSO to participate in the Action, but so far they have not attended any Action activities (100% from countries with reciprocal agreement).

- *Advancement and promotion of scientific knowledge through publications and other outreach activities. (Number of publications and other outreach activities that resulted from COST networking through the Action. Complete list should be given in an annex)*

COST members have reported a large number of scientific publications related to the COST FLARETEX topic and several of them resulted directly from the COST networking : 25 scientific papers, 31 conference contributions, 4 book chapters and 1 PhD project (see list in annex).

The proceedings of the Workshop on "Nanoparticles for flame retardancy: challenges and risks" (Krakow, 16.05.2013) were published within the series "Modern Polymeric Materials for Environmental Applications" (Vol. 5, Issue 1 and 2). These include 13 joint publications, realised by at least two COST MP1105 groups.
Abstracts of the presentations given at the workshop on "Elektrospun nanofibres for bio-inspired composite materials and innovative industrial applications in textiles" (Istanbul, 30-31 May 2013) were published in the Book of Abstracts of the 2BFUNTEX International Conference on Innovative and Functional Textiles and the full papers were distributed on USB-stick to all conference participants.

In addition all presentations of the industrial workshop on "Flame retardant functionalisation of textiles in industrial wet-chemical processes" (Twente, 5 October 2012) and the scientific workshop on "Innovative Flame Retardant Systems (applications and testing)" (Maribor, 27-28 March 2013) are published on the Action website (http://www.flaretex.eu/events.html).

Other outreach activities that resulted from COST networking through the Action :

- Design and creation of the Action website : www.flaretex.eu
- Design and creation of the Action logo and the Action poster and flyer, which are used for distribution of basic information on the Action at international meetings, conferences, etc. and are available for download on the Action webpage http://www.flaretex.eu/dissemination.html.

- *Activities and projects with COST network colleagues.*

Many new research collaborations between COST members were established in the 1st year. Some examples are given below :

- Collaboration of Politecnico di Torino, IT, with University of Bolton (Prof. B. Kandola), UK, and University of Lille (Prof. Serge Bourbigot), FR.
- Collaboration between Politecnico di Torino, and Department of Chemical, Materials and Production Engineering of Naples for joint work and papers.
- Agreement between University of Zagreb, Faculty of Textile Technology, Croatia, and Politecnico di Torino, Italy, for joint work and papers.
- Bilateral cooperation agreement expected between the National R&D Institute for Nonferrous and Rare Metals – IMNR, Romania and the University of Maribor, Slovenia.
- The Deutsches Textilforschungszentrum Nord-West GmbH, Germany, started collaboration with Dimosthenis Papakonstantinou (CRE.THI.DEV. - Creative Thinking Development, Greece), in order to submit a binational proposal on graphenes as new flame retardants for textiles.

- *The capacity of the Action members to raise research funds.*

IMNR, Romania: The new MANUNET project in partnership with Romanian and Spanish SMEs raises the Laboratory funding with about 150,000 EUR in period 2013-2014.

Institute of Natural Fibres & Medicinal Plants, Poland :

- Research grant within Applied Research Programme of the National Centre for Research and Development. New silicon-organic modification agents for natural fibres and fabrics.
- Research grant within OPUS General Grants of National Science Centre. The study of the phenomenon of synergism in reducing the flammability of the composites between modified natural fibres and halogen-free fire retardants.
- FP7-NMP-2012-SMALL-6 Smart nanostructured devices hierarchically assembled by bio-mineralisation processes".
- Cofinancing grants for EC RTD Framework Programme."Smart nanostructured devices hierarchically assembled by bio-mineralisation processes". Project submitted, evaluation pending.

EMPA, Switzerland : An Eureka research project has been started with industrial partners from Switzerland and Austria to bring a new flame retardant technology to the market (SUSPUR).

ANNEX

List of scientific publications

Scientific papers:

Jenny Alongi, Riccardo Andrea Carletto, Alessandro Di Blasio, Federico Carosio, Francesca Bosco, Giulio Malucelli (2013) “DNA: a novel, green, natural flame retardant and suppressant for cotton”. In: JOURNAL OF MATERIALS CHEMISTRY. A, vol. 1, pp. 4779-4785. - ISSN 2050-7496

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J. Alongi, R.A. Carletto, A. Di Blasio; F. Cuttica; F. Carosio, F. Bosco, G. Malucelli (2013) “Intrinsic intumescent-like flame retardant properties of DNA-treated cotton fabrics”. In: CARBOHYDRATE POLYMERS, vol. 96, pp. 296-304. - ISSN 0144-8617

Alongi J., Colleoni C., Rosace G., Malucelli G. (2013) “Phosphorus- and nitrogen-doped silica coatings for enhancing the flame retardancy of cotton: synergisms or additive effects?” In: POLYMER DEGRADATION AND STABILITY, vol. 98 n. 2, pp. 579-589. - ISSN 0141-3910

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E. Ivanov, I. Petrova, R. Kotsilkova, V. Mihailova. “Epoxy/Multi Wall Carbon Nanotube Composites – Structure, Viscoelastic and Nanomechanical Properties”. Nanoscience and Nanotechnology Letters (2013) (in press).

A. M. Grancarić, I. Prlić, A. Tarbuk, G. Marović. “Activated Natural Zeolites on Textiles: Protection from Radioactive Contamination in Intelligent Textiles and Clothing for Ballistic and NBC Protection”. Intelligent Textiles and Clothing for Ballistic and NBC Protection; (eds. Kiekens, P.; Jayaraman, S.) Heidelberg, Springer, 2012, 157-176, ISBN 978-94-007-0575-3.

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Carosio F., Alongi J., Malucelli G. (2013) “Textile flame retardancy through layer by layer assembled nanoarchitectures”. In: XXIII IFATCC International Congress, Budapest (Hungary), 8-10/05/2013. p. 35.

S. Bourbigot, F. Samyn, S. Bellayer, G. Fontaine and S. Duquesne “Influence of the nanomorphology on the reaction to fire of flame retarded polymer”. “5th International Seminar on Modern Polymeric Materials for Environmental Applications”, Proceeding in ‘Modern Polymeric Materials for environmental Applications’, Edited by K. Pielichowski, Published by Cracow University of Technology, pp. 49-58,Crakow (Poland), May 2013.

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PhD project

Title: “Improving Mechanical and Thermal Properties of Polypropylene using Three-Phase Nanocomposite Strategy”. Supervisor: Prof. D.Sc. R. Kotsilkova and Co-supervisor: Dr. Evgeni Ivanov