

TEHNOLOGII INOVAȚIONALE PENTRU DEZVOLTAREA DURABILĂ ÎN TEXTILE

THE TEXTILE AND LEATHER INDUSTRY PROMOTER FOR SMART PRODUCTS - MANUCOAT ERA NET PROJECT-

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Abstract: *For a long time, the textile and leather industry has surpassed the stage of conventional clothing products and has evolved towards multifunctional smart products that provide various functionalities to the user. Today the focus is on smart products, with protective properties for environments with different degrees of risk, products that provide superior wear comfort and safety properties, which can be obtained only by using unconventional technologies and advanced raw materials. At present, textile and leather industry achieves a symbiosis between unconventional technologies and tradition, culture and creativity.*

This paper presents aspects regarding this field at European and national level and the achievements in the research activity carried out by INCDTP, the only scientific research institute in this sector in Romania.

Key words: *nonconventional technologies, multifunctional materials, antibacterial, self-cleaning, self-sterilizing properties*

1. INTRODUCTION. General background at European and national level

The European textile and clothing industry has become increasingly diverse, creative and innovative which allowed in 2012 the achievement of a turnover of 165.3 billion Euros, exports of goods amounting to 42 billion Euros, with a workforce of 1.78 million people working in more than 181,000 companies [1]. Having a strong global competition, the European companies focus more and more on research and innovation to ensure sustainable competitiveness for the entire production.

The sector of technical textiles which recorded positive economic and employment trends in the EU is an example of "traditional sector" able to "redefine its identity" according to a new business model, adapted to the needs of the new industrial revolu-

tion by unconventional technologies (smarter, more inclusive and more sustainable).

Technical textiles are stimulating factors for other industries, by providing: lightweight, flexible, soft, (multi) functional, durable alternative materials; new flexible, continuous, versatile technologies; reliable, multifunctional, cost-effective functional components, parts of larger technology systems and solutions oriented to the users.

In this context, the field of technical textile and leather products is a strategic direction of sustainable research and development for various economic and social sectors: metallurgy, chemical industry, agriculture, construction, medicine.

Textile systems/products as a result of using fibers with high performance features and/or embedded functionalities and converging technologies, are increasingly replacing conventional materials in transportation, construction, health and the environment. Fashion or interior design market is also an attractive market for the textile and clothing industry by providing great potential to increase domestic and foreign production as a result of creativity, quality, sustainability and new business models/mass customization.

Research and education infrastructure in the field can provide the answer to both the development trends in industrial sectors and the changes in society by providing innovative products and solutions.

Materials and technologies used in the textile field are essential innovations that could respond to a huge variety of societal challenges. Technical textiles are stimulating factors in other industries, by proposing and providing:

- Alternative materials: lightweight, flexible, soft, (multi) functional, durable;
- New technologies: flexible, continuous, versatile;
- Functional components: reliable multifunctional, cost-effective, user oriented.

The **European Apparel and Textile Confederation organization - EURATEX** www.euratex.org has the role to correlate the research with industry, academia and public authorities in Europe. Euratex is an interface of the European environment in the field of textiles with the EU authorities in Brussels - Belgium, submitting to its members for analysis different aspects of EU economic policy. Euratex provides statistical information reports by its associated website: <http://www.euratex.org/cith>.

Currently, technical textiles account for over 25% of total European production of textiles, compared with 22% in 2007 [1]. It is estimated that the market of technical textiles evaluated in 2011 to 188.15 million Euros, will record by 2016 an annual increase of approx. 23%. (Source: EURATEX).

The significant share is represented by the security, protection and military field (30.4%), home and construction (22.3%), sports and leisure (15.4%), transport (14.4%), fashion (11.4%), medicine and health (6.1%).

The results of studies and research on nanotechnology applications in the textile industry will allow the production and marketing of:

- Textile materials with soil removal properties;
- Antibacterial textile materials with silver nanoparticles;
- Textile materials releasing fragrances contained in nanocapsules;
- UV protection textile materials treated with TiO₂ nanoparticles;
- Phase change materials (PCM) for temperature regulation of the body;
- Electroconductive textile fibres for smart, electrostatic textiles;
- Textile materials with energy generation properties (thermoelectric, solar etc).

The Romanian textile & leather industry – general aspects

The main competitive advantages of the textile – leather field in Romania are:

- A long tradition of this economic branch as supplier of large consumption goods and of specific products on the external markets;
- It achieves a surplus of products that are for valorised through export;
- There is a real competitive environment, due to the presence of numerous economic agents in this field;
- There is an important professional training network: 4 university centres with textile – clothing faculties in Iasi, Sibiu, Arad, Oradea;
- A favourable geographic positioning in relation to the main supply and sales markets.

Based on the sources of information provided by the Ministry of Economy in Romania, Direction for Industrial Policies, we are enumerating below some data referring to the textile, leather and footwear industry in Romania for 2013:

- Industrial production reached 20 050 million lei (a 6.5% increase compared to 2012), out of which: 4 106 million lei – textile products, 10 555 million lei – clothing products and 5 389 million lei- leather and footwear;
- Exports reached 4747.8 million Euros (a 3.4% increase compared to 2012), out of which: 899.1 million Euros – textile products, 2528.3 million Euros - clothing products and 1320.4 million Euros - clothing - leather and footwear products;
- Number of employees: 217 200 (lower by 0.6% compared to 2012), out of which: 32 000 – in the textile products subsector, 136 500 – in the clothing subsector and 48 700 – in the leather – footwear subsector.

The Romanian textile companies should give up on the cheap labour advantage and should aim to conquer a different position on the external markets, the segment of medium and high prices that correspond to a higher quality and a strong brand image, all these being reachable by substantial investment in nonconventional technologies, innovation, design, marketing and promotion.

In order to cope with these challenges, the Romanian companies are becoming aware of the advantages and, therefore, of the need to group in clusters.

Individual companies, especially the small and medium ones, do not have the strength to consolidate on their own on a mature market; this is why forming clusters is a solution to increase competitiveness and to create an infrastructure for business development, clusters being adequate environment for business cooperation, commercial information, communication, legal counselling [1-4].

2. INCOTP – PROMOTER OF INNOVATION AND DEVELOPMENT THROUGH RESEARCH

Papers I.N.C.D.T.P. stands out as a dynamic and flexible player on national and European level, addressing multidisciplinary researches in niche areas.

We are the only institute in Romania which has expertise and R&D facilities in the field of textiles, clothing and leather processing, having a tradition of over 60 years in the area.

Main activity area - Multidisciplinary applicative research in the field of textiles – clothing and leather – footwear – rubber consumer goods:

Other related activities that support the research activity:

- **The Technology and Business Incubator – ITA TEXCONF**, an innovation and technology transfer entity without legal personality that was set up within I.N.C.D.T.P. in 2007, with the objective to capitalize on the results of research in the textile field, to encourage the development of the private sector through innovation and technology transfer.

- **Technical Assistance and Services - laboratory testing and investigation.** The institute offers technical assistance and laboratory testing and investigation services for the Romanian textiles and leather companies through 2 accredited laboratories.

- **Publishing activity.** I.N.C.D.T.P. has its own Publishing House named CERTEX that edits & publishes technical reviews, books, and its own magazines – "Industria Textila" (Textile Industry) – ISI Thomson Reuters rated since 2007, the impact factor for 2013 being 0.475 – and Leather-Footwear Journal – B+ rated.

- **Professional training activities.** The institute is authorized as professional training provider since 2010.

INCDTP is actively participating in specific cooperation actions with the 4 clusters in the textile field: Romanian Textile Concept Cluster (Bucharest Ilfov and South Region), ASTRICO NE (North – East Region), Traditions Manufacturing Future (South – East Region) and Transylvania Textile & Fashion (Central Region). Through ITA TEXCONF Technology and Business Incubator, the institute has also collaborated with the Pole of Competitiveness in the textile and clothing industry - NOATEX and with other poles of competitiveness such as IND AGRO POL (agricultural field) and AUTOMOTIVE South-West Oltenia (automotive field), as well as with the Romanian Cluster Association - CLUSTERO.

2.1. European representative projects, incdtp as partner or coordinator

2.1.1. Integrated manufacturing process for textiles applications and wood protection- Manucoat

Programme: MANUNET ERA NET Project

Website: <http://www.manucoat.eu/>

The MANUCOAT research is focused on getting the visible light photocatalytic effect of textile and wood surfaces by developing of a system for plasma treatment of textile and increase wood substrates and deposition of doped nano-TiO₂, where dopants envisaged are Ag in order to provide solutions to manufacture self cleaning textiles and wood durability.

Main Objective of MANUCOAT project is the manufacture of new, long life and environmental stable photocatalytic materials with sensitivity in the visible region of the solar spectrum.

Innovative aspects:

1. new method to extend the absorption domain of photocatalytic compounds in the visible range, increasing the photocatalytic yield and photodegradation rate;

2. original synergistic strategy to manufacture new flexible, smooth nano-structured layers on textile and wood materials through the improvement of advanced physical methods;

3. manufacture at industrial scale textile products with self-cleaning effect, excellent and durable antimicrobial protection;

4. correlation of complex data analysis (physical, mechanical and thermal properties, morphological, biological) to evaluate the functional effects (the photocatalytic activity, self-cleaning and auto-sterilizing, antibacterial/anti-fungal efficiency) and to elaborate new method for photocatalytic effect assessment.

Results obtained:

Four methods were used for applying NPs of titanium oxide (TiO₂) and TiO₂ doped with silver: spraying, padding, electrospaying and sputtering. Padding and spraying have been used for the optimization method to achieve stable solutions for use in the electrospaying. In some cases, the samples have been pre-treated in plasma. We used three types of textiles: satin PES for surgical gown, PES for public space curtains and cotton for medical sheets and gowns. For photocatalytic effect assessment all the samples were stained with methyl orange and exposed to Xenotest for 7 or 14 hours.

The best results were obtained for following samples:

- *padding method*: satin and PES samples treated with 0.5 % Ag and TiO₂ and with or without plasma treatment or 0.5 %Ag and TiO₂ and acrylate binder;
- *spraying method*: satin samples treated with TiO₂ and PEI, UV and sample treated with TiO₂, 1.5% Ag and PEI, UV the stain was almost completely clean, dye has faded; UV treatment is beneficial, activates fiber and clean the surface;
- *electrospaying method*: satin sample treated with 20g/l TiO₂ doped with 0.5% Ag and stabilizer PAAS;
- *sputtering method*: sputtering process was applied for 10 min. Samples satin and PES sputtering with TiO₂ and TiO₂/Ag1% target cleaned very well.

2.1.2. A pilot line of antibacterial and antifungal medical textiles based on a sonochemical process – SONO

Programme: Seventh Framework Programme – FP

Website: <http://www.fp7-sono.eu/>; <http://www.certex.ro/Proiecte/Sono/>

Main Objective: To apply at semi-industrial level a sonochemical technology patented at laboratory level by the project coordinator, Bar-Ilan University in Israel, in order to obtain antibacterial and antifungal medical textiles.

Innovative aspects:

- At the level of FP7 project consortium: the development of sonochemical technology at semi-industrial level, a technology with a major potential for the textile industry and also for other industries.
- At the level of Romanian partners: definition and implementation of a methodology for the investigation of nanomaterials. I.N.C.D.T.P. has identified and elaborated an experimental matrix to test nanomaterials with antimicrobial function obtained by the ultrasound application, starting from the macroscopic structure of the textile backing – physical-mechanical and physical – chemical properties to the micro and nano structure – characteristics of the nanoparticles on textile materials' surface. The Romanian company SC DAVO STAR Impex SRL also participated in this project and experimented the nonconventional technology for obtaining textile materials for preventing nosocomial infections.

Results obtained:

- At the level of the European consortium two sonochemical pilot lines were built and they were installed at the premises of the textile SMEs partners in the project, one in Romania- SC DAVO STAR Impex SRL Bucharest, one in Italy.

- Identification of the main technological parameters that govern the deposition process and their optimization for an even and homogeneous impregnation of the textile materials' surface;
- Production of textile materials with antibacterial and antifungal properties, impregnated with metal oxide nanoparticles;
- At the level of Romanian partners: complex characterization from the perspective of technical parameters of the textile materials surface impregnated with metal oxide nanoparticles; acquisition of know-how referring to nanotechnologies applied on textile backings, including technological aspects – methodologies and optimum parameters for the deposition of nanoparticles and analytical aspects referring to the understanding of the behaviour of various textile backings upon depositing nanoparticles with various chemical structures.

2.1.3. Innovative technologies for leather sector increasing technological competitiveness by RDI, quality of life and environmental protection – INNOVA-LEATHER

Programme: Sectorial Operational Program "Increase of Economic Competitiveness" POS CCE, Axis 2, Operation 2.1.2 "Complex research projects fostering the participation of high-level international experts"

Website: www.innovaleather.ro

Main objective: developing new environmentally friendly “clean technologies”, alternatives to chromium tanning and valorisation of resulting leather wastes. This new system includes the development of new tanning agents (Knowledge-based Tanning Agent “KTA”), establishing new tanning technologies and obtaining a new leather assortment - “wet-white” [5,6].

Technical and scientific objectives:

- Synthesis of new tanning agents (Knowledge-based Tanning Agent - KTA);
- Development of new eco-technologies for leather pre-tanning/ tanning;
- Development of a new type of “wet white” leather;
- Development of new conversion procedures of “wet white” leather wastes into raw materials for added value products with applications in various fields;
- Life Cycle Assessment studies for the newly developed processes and products, compared to currently practiced methods - chromium salt tanning technologies (“wet blue”), storing/incinerating wastes, taking into account the environmental impact as well (e.g. of biodegradable auxiliaries).

Results obtained:

- 3 inorganic/organic tanning / pre-tanning agents & 3 new biodegradable auxiliary materials;
- 1 new “wet white” leather type;
- 3 new cosmetic products;
- Fertilizers for agriculture obtained from wet white waste conversion;
- 1 Technological Transfer Center & 1 Training Center for Leather and Footwear;
- 3 new types of ecologic finished leather types: leather for footwear, clothing and upholstery.

2.1.4. Nanostructured photocatalytic textiles – FOTOCAT

Programme: EUREKA

Website: <http://www.eurekanetwork.org/project/-/id/8080>;

<http://www.fotocatproject.eu/>

Main Objective: development of self-cleaning, self-sterilizing and antibacterial textile materials by coating textiles with new nanostructured photocatalytic compounds with extended absorption in visible range.

Technical and scientific objectives:

- Design, synthesis and characterization of new photocatalytic compounds based on multiwalled carbon nanotubes (MWCNT) / TiO₂ nanoparticles and nanopowders active in UV-vis range;
- Development of new technological processes (ultrasonic spray deposition technique) to coat the textile materials with transparent, thin nanostructured photocatalytic films;
- Analysis of new textile structures and assessment of photocatalytic, self-cleaning, self-sterilizing performances, antibacterial/antifungal activity;
- Transposing the optimized technologies at pilot scale.

Results:

- MWCNT-TiO₂ hybrid compounds;
- Techniques for MWCNT-TiO₂ coating on textile materials;
- Photocatalytic textiles;
- Characterization of photocatalysts & photocatalytic textiles;
- Life cycle assessment of photocatalytic textile materials.

2.1.5. Tick repellent multifunctional protective textile materials – TICKoTEX

Programme: EUREKA

Website: <http://www.eurekanetwork.org/project/-/id/8083>

<http://www.tickotextproject.eu/>

Main Objective: development of novel multifunctional textile structures that

include biological active compounds extracted from plants, to prevent the spreading of infectious diseases such as Borreliosis and other tick-borne bacterial diseases.

Technical and scientific objectives:

- New biological active compounds, as a real alternative to currently used insecticides, characterized by high toxicity and low efficiency against ticks;
 - Reproducible and efficient systems for encapsulating active compounds;
 - New applications for integrating microcapsules on the surface of textile materials, providing flexibility, uniformity, breathability and lasting coating of repellent layers;
 - Evaluation of products effectiveness by performing repellence tests for both biological compounds and finished textile products;
- Validation of technology both at laboratory and at industrial scale.
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