

Welcome to InSuLa - INNOVATIVE MATERIALS AND TECHNOLOGIES FOR SUSTAINABLE LEATHER MANUFACTURING FOR AUTOMOTIVE

GENERAL INFORMATION

Project code: COFUND MANUNET III InSuLa-1

Program PN III: European and International Cooperation; Subprogram 3.2 - Horizon 2020

Project type: ERANET

Contracting authority: Executive Unit for Financing Higher Education, Research, Development and Innovation (UEFISCDI)

Contract No.: 37/2018 (for Romania); Finalization Year: 2020; Project duration: 24 months

Romanian coordinator: INCDTP-ICPI, Bucharest

Project Director: Elena Badea

OBJECTIVES AND CHALLENGES

InSuLa focuses on chrome/metal-free leather for automotive industry that meets the very strict technical specifications in terms of flame resistance, anti-fogging and stain resistance characteristics as well as the demand for recycling materials, while increasing the eco-compatibility of chemical auxiliaries and minimising the environmental and health impact of tanning and finishing processes.

WHY? The leather automotive industry is facing a number of challenges including a continuously tightening regulatory framework for safer and cleaner chemicals and technologies and the ongoing need to differentiate in terms of innovativeness, design, appearance and comfort. The new auxiliaries and chrome/metal free technologies envisaged by the Project are in line with the current driving demand for leather chemicals and leather technology in the future years.

The InSuLa project will focus on the **development of novel safe and non-toxic nanocomposites** as

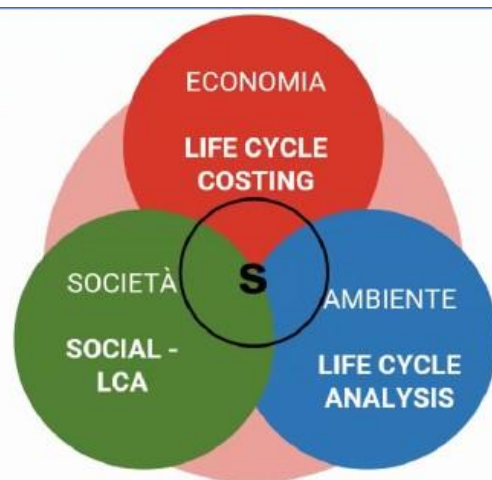
- **inorganic fillers** allowing to decrease the amount of synthetic tannins, typically phenol or naphthalene-formaldehyde-based resins with high environmental impact
- main **constituents of additives imparting fire resistance and self-cleaning properties**, targeting the substitution of brominated (PBB, PBDE, HBCD, TBBPA, TBP) flame-retardants which were shown to be persistent in the environment, bio-accumulative in wildlife and humans, toxic to laboratory animals and wildlife, producing reproductive, developmental, and systemic effects in lab tests. Their use is restricted from July 2006 by the Restriction on Hazardous Substances (RoHS) Directive implemented by EU.
- A **new knowledge based organic tanning agent (KTA) from a natural polymer**, easily biodegradable with low toxicity, naturally occurring in the cell walls of brown algae. The new KTA from renewable sources is a sustainable alternative to formaldehyde (FA) and glutaraldehyde (GA) which were shown to have adverse health effects on humans and contribute to greenhouse gas emission as petroleum derived chemicals.
- A **new chrome/metal-free technology** for pre-tanning / tanning / retanning leathers without the use of FA, GA and/or metals, and including eco-friendly flame-retardant treatments for the production of high performance leathers which meet the demanding standards requested by the automotive industry: soft but resilient, perspiration- and migration-resistance, low in volatile organic compounds, fog and odour reduced emissions in car interior, less weight (that means less fuel consumption and less CO₂ output), light and heat fastness, high dyeability.

The **objectives of InSuLa** require **advanced solutions** at the cutting edge of **modern tanning chemistry** and **material science** in an interdisciplinary framework that will be developed within the project.

IMPACT The automotive leather segment remains the fastest growing sector in the leather industry and the whole supply chain is undergoing a major industry transformation with a major issue as environmental sustainability. So far, the growth of the leather chemicals market has been spurred by the development of the automotive industry.

It is therefore highly expected that the accomplishment of the Project objectives will generate a new business opportunity for tanneries and chemical suppliers, and thus stimulate the whole supply and value chain.

In **InSuLa**, **enterprises** acting in the business of chemicals for leather tanning and finishing, and leather tanning, **academic and research centers** of excellence in the field of synthesis and characterization of nano- and advanced materials, and in tanning chemistry have joined forces in this **multidisciplinary approach** aiming at developing different nano-materials and auxiliaries, as well as technologies in response to real market needs, the testing of such materials and technologies, the assessment of their environmental impact, and their industrial scalability.



INTERNATIONAL CONSORTIUM

InSuLa is industry-driven project led by the experienced Italian company **KEMIA TAU (KT)**, and the consortium comprises a partnership with complementary skills in leather chemistry (KT), leather process technology at lab and pilot scale (**INCDTP-ICPI, Bucharest**), and industrial scale (**PIELOREX S.A.**), LCA and LCCA of innovative manufacturing processes (**Department of Economics, University of Turin, UNITO**), research and innovation in (nano)materials (**Department of Chemistry, University of Turin, UNITO**) and of their application to leather technologies (**INCDTP-ICPI**). This results in a tight interconnection among technological, sectoral and commercial aspects (KT and PIEL), sustainability analysis (UNITO) and scientific/technological research (ICPI, UNITO).

KEMIA TAU (KT), the coordinator of the project, has an extensive experience in consortium and project management involving both industrial and academic partners. Since 1973 KT has been operating at on world markets, opening headquarters and branch offices in the countries which are global leaders of leather industry as Poland, Portugal, Russia, Turkey, India, China, Korea, Argentina and Brasile, and supplying its clients with advanced products, qualified technical assistance and technology consulting. KT's portfolio of solutions for the specific needs of world-wide clients is the result of a constant expert chemical specialized research and proves its ability to carry out independent and/or collaborative research to solve practical business technology.

So far, KT is closely working with prestigious industrial partners such as Berluti of Louis Vuiton Group and a number of important tanneries from Italy (Mastrotto Group, Dani) and abroad (Tata, India and Ecco, Holland) and a number of tanneries which supply leather for luxury brands (Gucci, Prada, Salvatore Ferragamo, Valentino, TOD's, Hermes, etc.), design furniture (Poltrona Frau), motorcycle clothing, sportswear and protective gear (Dainese, Kering Group), etc.

The quality and environmental management systems applied by **KEMIA TAU** are ruled by UNI EN ISO 9001:08 and UNI EN ISO 14001/2004 standards. According to UNI EN ISO 9001:08, KT follows a specific procedure for design and development. The quality of KT's solutions is supported by special

safety and control measures that cover the entire INDUSTRIAL cycle in full accordance with the REACH protocol, from raw materials to the final product.



KEMIA TAU[®]

**CHEMISTRY
BEHIND
LEATHER**

<http://www.kemiatau.com/>

The **National Research & Development Institute for Textiles and Leather (INCDTP)**, Bucharest, was established in 1996, by merging Textile Research Institute (established in 1951) with **Leather-Footwear Research Institute (ICPI)**, established in 1956, being the only Romanian institute performing R&D in textile and leather fields. INCDTP-ICPI have 176 employees of which 68% are attested RD personnel. Since 2005 INCDTP-ICPI has managed 67 international projects and more than 200 national projects. Scientific results for 2012-2016 period: 121 ISI-indexed articles, 160 peer-reviewed articles, 25 books, 9 book chapters, 591 scientific communications, 42 patents, 46 patent applications and 96 innovation awards (<http://www.certex.ro/Rapoarte/>).

The Leather Research Department

Leather Research Department of ICPI is recognized for developing new chemical auxiliaries, new materials (compact retanning agents, wet-white leather), nanomaterials (nano silver, nano titanium dioxide doped with nano silica, iron, nitrogen, silver) and smart technologies in the area of biocides, flame retardants, self-cleaning materials with low impact on the environment and consumers, green technologies for recovery of collagen and keratin based by-products.



<http://www.icpi.ro>

<https://erris.gov.ro/Leather-Research-Department>

PIELOREX S.A., former Jilava Mineral Tannery, is the biggest tannery in Romania with integral private structure. PIELOREX processes bovine hides, manufacturing high quality finished leathers and splits for footwear, leather goods, upholstery, harnesses, protecting clothing, wet blue and crust leathers both for internal and external market. PIELOREX has an experimented R&D department that has developed applicative research activities in the frame of national and European RDI programs, in partnership with research institutes and universities (15 projects in collaboration with ICPI). In 2008-2010 PIEL coordinated two projects within the INOVATION National Program.



<https://www.pielorex.ro/>

University of Turin (UNITO). As a whole, the Department of Chemistry (www.chimica.unito.it; 90 permanent staff, ca. 60 PhD and postdocs) carries out research activities on a wide range of subjects related to various branches of Chemistry. Since 2012 it is managing 14 European projects, 7 national

projects and 45 local projects. In particular, the Chemistry@UNITO team in InSuLa brings to the project competencies in the field of preparation and characterization of nanomaterials, and in recent years intensively investigated most of the nanomaterials relevant for the project, namely nanohydroxyapatite, nanosilica and nanotitania, also in interaction with biomacromolecules.



<http://www.chimica.unito.it/do/home.pl>

The role of the Management@UNITO team members of the Department of Management (www.management.unito.it; 80 permanent staff, 30 PhD and postdocs) is based on their expertise in management accounting and in environmental impact assessment of the economic activities (significant is the creation of an academic spin-off doing business with life-cycle analysis, Scatol8, www.scatol8.net).



<http://www.management.unito.it/do/home.pl>

ACHIEVEMENTS

Mid-term project summary suitable for web publication

The first year of implementation of InSuLa was aimed to the implementation up to pilot-plant level of five main processes devoted to new technologies for automotive leathers:

- 1) preparation and characterization of oxidized sodium alginate (OSA) (responsible ICPI)
- 2) development of a new Chromium-free tanning technology based on OSA (responsible ICPI and Pielorex)
- 3) preparation of hydroxyapatite nanoparticles (nano-HA) (responsible UniTO-CH)
- 4) formulation of tanning auxiliaries based on commercial clays, nanosilicas and nanotitania (responsible: ALL)
- 5) formulation of tanning auxiliaries based on nano-HA (responsible: UniTO-CH and Kemia Tau)
- 6) definition of the objectives of the LCA (UniTO-MNG)

Final-term project summary suitable for web publication

The main target of InSuLa was to develop innovative chrome/metal-free leather for automotive industry with improved flame resistance, anti-fogging and stain resistance characteristics. In the same time, it aims at increasing the eco-compatibility of chemical auxiliaries and minimizing the environmental and health impact of tanning and finishing processes.

The main achievements were:

- 1) A new knowledge based organic tanning agent from alginate, easily biodegradable and with low toxicity, as a sustainable alternative to formaldehyde and glutaraldehyde.
- 2) Set up of the synthesis and characterization of nanohydroxyapatite (nano-HA) (reproducibility tests in terms of size, morphology, specific surface area (SSA) and nanostructure) on a laboratory scale.
- 3) A new metal-free tanning technology based on the combined use of alginate tanning agent and tara extracts (both from renewable sources), and wet finishing with cost-effective nano-HA as eco-friendly flame-retardant for the production of high-performance leathers for automotive industry.

4) A new metal-free tanning technology based on the combined use of alginate tanning agent, tara extracts and collagen hydrolysate (from tannery proteinaceous wastes), and wet finishing with nano-HA as eco-friendly flame-retardant for the production of high-quality leathers for design industry.

5) Small pieces of leather (ca. 2x2 cm) were successfully wet-finished; experimental (SEM-EDX) observation indicated that nano-HA entered within the thickness of the leather samples, and its interaction with the collagen matrix was proved by DSC and ATR-IR.

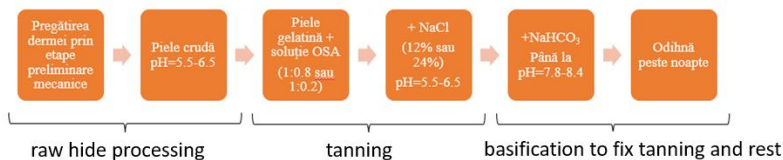
6) Up-scale at industrial pilot level of the metal-free (wet white) designed technologies. White crust leathers from wet white hides with a good fullness and softness, light colors (almost white / crème) and physical-chemical and mechanical characteristics that meet the requirements for automotive leather were obtained.

7) The life cycle thinking assessment tools have allowed the identification of environmental and economic aspects already at pre-industrial level production. Through collaboration with the companies involved, it was possible to build and feed the life cycle inventory relating to nano-formulation production and its application in tannery. Then, it was obtained an economic characterization in order to implement a life cycle cost model and therefore to improve the knowledge and management of the economic variables referred to innovative products and processes.

➤ Products

- New product: preparation of nano-HA suitable for leather fireproofing (UniTO-CH)
- New sustainable tanning technologies: 3 new tanning technologies (metal free) (ICPI)
- New products: 3 new leather assortments for automotive industry (ICPI and PIEL)
- New organisational method: The “Life Cycle Management” tools have been applied to the manufacturing realities. On the base of an accurate data collection, including direct electrical monitoring, LCA and LCC have been implemented for evaluation of traditional and innovative products performances. (UniTO-MNG)

Pilot-plant upscaling of the preparation of OSA tanned leather



Step	Tanning		Observations
	quantities	procedure	
Tanning	100% bath + 5-25% lyophilized OSA+ 4-6% NaCl	- stirring the sample in bath with salt for 15-20 min - slowly adding OSA and stirring for 6-8 hours - rest overnight	- initial pH value between 4.5-6.5
Basification	+ NaHCO ₃ until pH value reaches 8	- slowly adding NaHCO ₃ solution - stirring for 4-6 hours	control pH value: between 7.5-8.5 tanning capacity: T_s = 84-86°C



Patents

- Compozitie pe baza de proteine recuperate din deseuri de piele si extracte din alge brune si procedeu pentru biotabacirea pieilor
- Autori: M. Crudu, E. Badea, M.-C. Micu, L. Miu (ICPI)
- Application no: A/00235 din 30.04.2020

➤ Publications

- Authors: E. Badea, M. Crudu, C. Carsote, C. Sendrea, M.C. Lupas, L. Miu
Title: Stabilisation of collagen by alginate dialdehyde for eco-sustainable tanning
Meeting name and place: XL National Conference on Calorimetry, Thermal Analysis and Chemical Thermodynamics, Pisa, Italy
Year: 17-19 December 2018
Partner involved: ICPI
Poster communication
- Authors: M.-C. Lupaş, E. Badea, M. Crudu, C. Şendrea
Title: Sodium alginate for sustainable leather tanning
Meeting name and place: The 9th International Conference of the Chemical Societies of the South-Eastern European Countries (ICOSECS 9), Targoviste
Year: May 8-11, 2019
Partner involved: ICPI
Oral communications
- Authors: M.-C. Lupaş, E. Badea, M. Crudu, C. Şendrea, C. Carşote
Title: Interaction of collagen with natural compounds and nanoparticles in leather making process – a micro-DSC study
Meeting name and place: Summer School and Workshop in Calorimetry and Thermal Analysis 2019 - Calorimetry and thermal methods in material science, Lyon, France
Year: June 16 - 21, 2019
Partner involved: ICPI
Poster
- Authors: E. Rebba, P. Ivanchenko, S. Bordignon, M. R. Chierotti, E. Badea, M. C. Lupas, R. S. Evola, E. Vesce, R. Porcaro, G. Martra.
Title: Nanomaterials for sustainable leather products
Meeting name and place: 16th International Conference on Nanosciences & Nanotechnologies (NN19), Thessaloniki, Greece
Year: 2-5 July 2019
Partner involved: Unito-Chemistry
Oral communication
- Authors: Maria-Cristina Lupaş, Elena Badea, Marian Crudu, Claudiu Şendrea, Cristina Carşote, Simona Maria Păunescu, Iulia Maria Caniola
Title: Interaction of collagen with natural compounds and nanoparticles in leather making process
Meeting name and place: 8th International Conference on Advanced Materials and Systems ICAMS 2020, Bucharest, Romania
Year: October 1-3, 2020
Oral communications
- Authors: Maria – Cristina Micu, Elena Badea, Marian Crudu, Erica Rebba, Gianmario Martra
Title: Nanomaterials for biodegradable leather manufacturing
Meeting name and place: 6th International Nanotech & NanoScience Conference and Exhibition. NanoTech Paris 2021.
Year: 6/23/2021 – 6/25/2021
Oral communications

➤ **Dissemination**

- **Workshop InSuLa** within the the 7th INTERNATIONAL CONFERENCE ON ADVANCED MATERIALS AND SYSTEMS (ICAMS 2018), Bucharest, Romania, 18-20 October 2018

➤ **Project meetings**

- **Kickoff meeting** – 17 May 2018, Kemia Tau, Cassa, Italy



- **1st Project meeting** – 19 October 2018, Bucharest, Romania
- **Mid-term Project Meeting** – 24 September 2019, Kemia Tau, Cassa, Italy
- **Final Project Meeting** – 1 December 2020, Turin, Italy, online