

Project full title: Nanostructured Toughened Hybrid Nanocomposites for High Performance Applications

Project acronym: NANOTOUGH

Grant agreement no: 213436

Type of funding scheme: Large Scale Integrating Collaborative Project

List of beneficiaries: Aalborg University AAU Denmark – Coordinator, Chemical Research Institute ICECHIM Romania, University of Hamburg UHAM Germany, Technical University of Denmark DTU Denmark, University of Genova UGDIE Italy, Association pour la Recherche et le Développement des Méthodes et Processus Industriels ARMINESCEMEF France, Centro Ricerche Fiat CRF Italy, The Danish Technological Institute DTI Denmark, Laviosa Chimica Mineraria LCM Italy, FPK S.A. FPK Spain, Aviospace AVS Italy.

Main objective: The aim of the project was to obtain new nanocomposite materials based on polypropylene (PP) and nanolayered silicates, characterized by a good toughness - stiffness balance which would replace materials currently used in the manufacture of automotive parts and in other high performance applications. The development of new materials was motivated by the growing demand of the industry for functional materials, cheaper and lighter, with tailored properties for applications and which are not currently available on the market.

A main scientific objective of the project was the deeper understanding of interfacial properties in polyolefin nanocomposites in order to solve the current problems that hinder the commercialization of these materials. Medium-term objective was to obtain materials with superior properties for specific applications and for new products with affordable price.

The role of Romanian team:

In this project, ICECHIM was responsible of work package no. 1 (WP1 Leader). The main task of ICECHIM was to obtain PP nanocomposites using new compatibility agents developed on the basis of functionalized or non-functionalized block copolymers and new dispersing agents based on PET waste, in order to allow uniform dispersion of nanofiller in PP matrix, strong interaction between the components and outstanding improvement of PP properties.

Research infrastructure:

ICECHIM participated in the project with complete equipped laboratories for:

→ living anionic polymerization, including solvent and monomer high purification systems, Büchi polymerization glass reactors, high purity nitrogen generator and set-up for polymer removal from solution;

→ obtaining and characterization of polymer composites and nanocomposites: Brabender Plastograph (capacity: 30 and 50 cm³); Brabender co-rotating double screw extruder (screw diameter D=20 mm; length = 40 mm); Leistritz co-rotating double screw extruder (screw diameter D=34 mm; L/D = 34 mm); intensive mixer with 25 l capacity; Zwick tensile-tester type 1454R modified and coupled to a computer; Ceast impact tester for Izod and Charpy impact strength; Durometers for Shore A and D Hardness; Universal system Instron type 3382, for mechanical testing equipped with video extensometer; DRON-2, 0 X-ray diffractometer with horizontal goniometer; AFM microscope for the investigation of samples surfaces; Thermal & Thermomechanical Analysis System: TA Q5000 IR Instrument (TGA), TA Q2000 Instrument (DSC), SDT Q600 Instrument (Simultaneous DSC-TGA), Q800 Mechanical Analysis Instrument (DMA).

Human resources involved in the project:



ICECHIM participated in the Consortium by its Polymer Department, mainly the Elastomers Research Group and Plastics Characterization and Processing Research Groups: 17 Senior Scientific Researchers (8 CS I, 4 CS II, 5 CS III), including 6 PhD, 3 Scientific Researcher, 1 Informatician, 1 Economist, 3 Technicians and 1 Laborant. One of PhD students has graduated the doctoral thesis in Denmark at Aalborg University (the coordinator of the project) and now she is making there the second postdoctoral stage.

Results: Functionalized and non-functionalized block copolymers and oligoterephthalates (obtained by PET waste valorisation) were developed and their efficiency as compatibilizer agents in nanocomposites based on PP was evaluated. Both types of compatibilizers are subject to patent applications filed with the Romanian

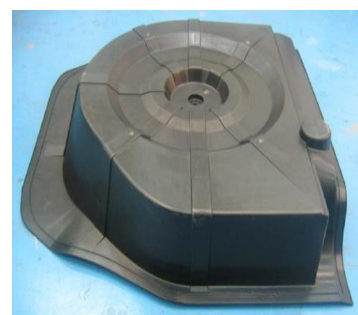
Patent Office. Several milestones: the degree of interaction between the components was evaluated, masterbatches were prepared being established the ratio between the components, their mixing order and the technological processing parameters.

As a result of ICECHIM's work, new high performance materials have been developed, characterized by an increased toughness (15 times higher as compared to the reference), an improvement of creep resistance and of the resistance at high temperature, increased resistance to repeated loading cycles and better barrier properties. Moreover these new developed materials showed good results when tested by end users partners of the project. Two industrial samples of masterbatch (~ 300 kg) were made by ICECHIM and sent to the end user (FPK) to manufacture auto parts and for material and parts characterization. The new materials were tested in combination with glass fibre to achieve car bumpers leading to weight reduction of the part by more than 30% in comparison with current solutions.

The materials developed by ICECHIM were also validated for spare wheel well, whose behaviour to impact improved by 50%.

	Current		New
			
No. components	6	50% Reduction	3
Weight	7,4 Kg	45% Reduction	4 Kg

Bumpers



Spare wheel well

One advantage of these materials is the easy recycling at end of life of the parts since they do not contain metal inserts.

The impact of results on the Scientific Community and Romanian Society

The results of the Nanotough project have been used by PhD students in their doctoral theses, or by PhD in their post doc stages, the topic of which being exactly in the field of functionalized polymers, nanocomposite materials and characterization methods.

Using eco-friendly modifiers and solvents obtained from renewable bio-resources for polymerisation, the range of useful bio-based products will be wider, contributing towards implementation of the integrated bio-refinery in Romania, one of the main visionary projects of EU supporting the bio-based economy of the future. Also, avoiding the use of oil-based chemicals (aromatic, aliphatic and cyclo-paraffinic hydrocarbons) the environment will be protected, and the working conditions will be significantly improved.

Using PET waste for terephthalate oligomers-based compatibilizer's preparation environmental problems will be solved.

The materials developed by ICECHIM in Nanotough project are easy to produce by several interested SMEs, both from Romania and abroad. In Romania, there is interest for several SMEs involved in

- PET recovery to develop recycling capacities for making new value-added products;
- bitumen obtaining to develop an installation for 10000 t/year of block copolymers obtaining.

Large scale dissemination was done through publication of articles and papers presentation in national and international scientific meetings.

Integration of Romanian team in international research networks

Following the work of ICECHIM new materials with superior performance for automotive industry, aerospace, packaging and tires have been developed. All these results determined the selection of this project by the EC as a "Success Story". Also, ICECHIM was asked to participate as a partner in a new FP7 project, on-going since November 2012, *The Electric Vehicle revolution enabled by advanced materials highly hybridized into lightweight components for easy integration and dismantling providing a reduced life cycle cost logic (EVOLUTION), GA 314744.*