Newsletter
April 2020

in-built **T**riggered **E**nzymes to **R**ecycle **M**ulti-layers: an **IN**novation for **US**es in plastic packaging

FOREWORD

TERMINUS has started one year ago. This project brings together 13 partners from all over Europe, to work on the recycling by-design of plastic packaging multilayer applications.

During the first year of research activities many results have been acquired. We have selected the most promising enzymes, capable of degrading the adhesives or the tie layers used in production of multilayers. To account for the conditions of processing operations, and specifically of encounters with high temperatures, the enzymes have been protected to render them resistant to such temperatures. A favourable level of thermal protection has been acquired, given time durations compatible with the processing times. In addition to protecting the enzyme, it is necessary to control its triggered release - in the past year on-demand enzyme triggering was exemplified. However, in the coming months we face challenging work, as we start the processing of TERMINUS multilayer films with embedded, shielded and triggered enzymes. Likewise, recycling demonstrations are to commence, as well as implementations on original developments related to circular economy and life-cycle assessment.

Furthermore, TERMINUS actively participates in the Plastic Circularity Multiplier initiative. The researchers from TERMINUS have disseminated results in congresses and conferences throughout the past year. The obtained results are cause for optimism in the successful implementation of this technology.

In the first TERMINUS newsletter, a focus will be on Sigma as the project coordinator, its contributions and expertise. Moreover, an essential “task force” to this project are the “Young Terminators”. We are happy to highlight their essential contribution in this newsletter.

Vincent Verney

TERMINUS coordinator

About Vincent

CNRS researcher, Polymer Rheologist and Chemist, founder of the CVP (Cycle de Vie des Polymères) research group at ICCF in Clermont-Ferrand (France), Vincent is a scientific expert of the life cycle of plastics and their environmental impacts. (Co)Author of 119 publications in scientific international journals (h factor 23), 160 conferences in international congresses (of which 14 invited), one patent, one book and five chapters are testament to his expertise.

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ABOUT THE PROJECT

TERMINUS addresses the challenge of unlocking recycling and reuse of flexible multi-layer packaging materials. While highly functional, the complex structures and inseparable components of such packaging pose obstacles in their end-of-life treatment.

With a range of smart enzyme-containing polymers, TERMINUS aims to tackle the mentioned obstacles. These polymers would act as adhesives or tie layers in the manufacturing of multi-layer packaging and would, when triggered, through intrinsic biodegradation properties allow for an efficient separation of the different layers in a packaging. The separated layers can then be recycled through conventional recycling processes.

The new technology will allow for the development of biodegradable PUR-based adhesives for adhesive and extrusion coating lamination, as well as biodegradable biopolymer-based tie layers (PBS, PLA, PPC or PCL) to be used in blown extrusion.

With the successful implementation of TERMINUS, expected results will lead to a 15% improved economy efficiency, 80% reduction of the landfilling rates for multi-layer packaging as well as 50% decrease of overall landfilling rates of plastic, along with a 65% decrease in the CO2 emissions.

The project started in January 2019 and its perceived duration is set at 49 months.

Multi-layer packaging is mostly used in applications with specific functional requirements, such as for instance protection against microorganisms, moisture or oxygen. These functionalities allow for extended life of packaged products. Most common applications include food packaging, personal or home care products, pharmaceuticals, etc.

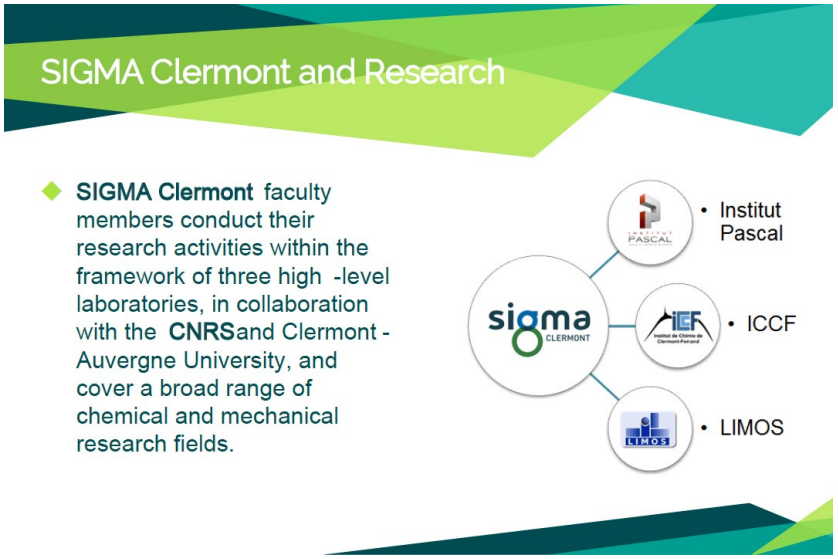
SIGMA CLERMONT

Sigma-Clermont is a Graduate School for Chemistry and Mechanical Engineering, located in Clermont-Ferrand. Its history is a unique alliance between Mechanics and Chemistry, resulting from the merging of Ecole Nationale Supérieure de Chimie, 4th oldest school in France founded in 1908, and IFMA, School of advanced Mechanical Engineering founded in 1991 with close industry relations.

Sigma hosts three Joint Research Units 'Unité Mixte de Recherche' (UMR), under the joint supervision of SIGMA Clermont, Université Clermont Auvergne (UCA) and the Centre National de Recherche Scientifique (CNRS).

JRU, ICCF and Institut Pascal are involved in the TERMINUS project. Sigma ensures the coordination of the project with the support of Benkei, while its researchers are tasked with activities across all the different Work Packages of the project. The main expected contribution from Sigma in the project concerns:

- Chemistry of the formulations used in enzyme activation, enzyme shielding, enzyme triggering, adhesive and tie layer formulations.
- Demonstration of the sorting and recycling of the TERMINUS multilayers
- Environmental and Circular Economy assessments
- Dissemination and Communication



YOUNG TERMINATORS

ASTRID DELORME

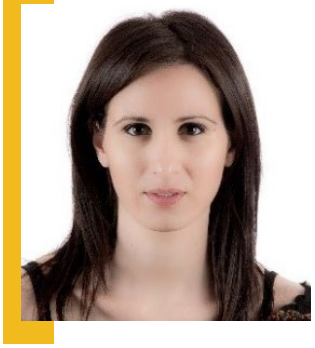
Astrid is a post-doctoral researcher at SIGMA-Clermont, where she mainly works on the recyclability assessment of the smart enzyme-containing polymers designed within the TERMINUS project. She is also screening the methods of making the enzymes more heat resistant. Astrid completed her MSci in Chemistry at the University of Nottingham, as part of which she spent her third year at the University of Melbourne. She then pursued a PhD within the EPSRC Centre of Doctoral Training in Sustainable Chemistry at the University of Nottingham. Her PhD project aimed to find sustainable solutions to alcohol oxidations and the project was heavily dependent on analytical chemistry. She has a strong interest in analytical chemistry and sustainable innovations striving for a better global environment.

BARNABÉ GOLLIER

Barnabé holds a Master's degree in chemistry and bioprocess technology, from the University of Ghent. He wrote his thesis on the environmental impact of the feedstocks of the oleochemical industry, in partnership with Belgian company Oleon. He joined OWS in October 2019 as a project engineer in sustainability assessment, where he is responsible for the sustainability assessment tasks in commercial projects and in various European research projects, including TERMINUS. Within TERMINUS, he will carry out the environmental and economic sustainability assessment of the developed products through the use of life cycle assessment and life cycle cost assessment methodologies, and will be involved in the development of a circular economy assessment tool for the project - activities which fall under the scope of Work Package 7, that he leads.

ANGELA ROMANO

Angela graduated in Industrial Chemistry from the University of Bologna in 2017. She spent six months at the University of Aix-Marseille in 2016 for her Master's thesis in organic chemistry. After graduation, she got a scholarship to spend a year as a postgraduate researcher at Imperial College of London. She has research expertise in organic synthesis and in the characterization of metallic and plastic materials properties using different techniques. She is currently a research assistant for TERMINUS at the University of Bologna, in the Department of Civil, Chemical, Environmental and Materials Engineering. She is involved in the selection of biodegradable tie layers and PUR adhesives, characterization of molecular and thermal properties of degraded products, and in the encapsulation and triggering of enzymes.

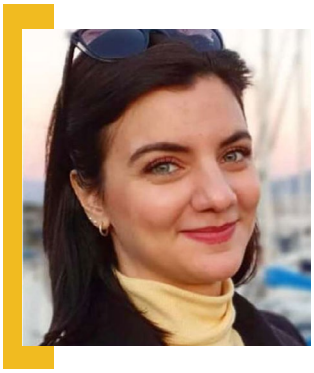


ANTONELLA ROSATO

Antonella graduated cum laude in Molecular and Industrial Biotechnology, and she earned a Ph.D. in Civil, Chemical, Environmental and Materials Engineering at the University of Bologna. From January 2017 she is a post-doctoral Research fellow in the Department of Civil, Chemical, Environmental, and Materials Engineering the same department. From April 2019 she is working on TERMINUS on the identification and selection of commercial enzymes able to hydrolyze tie layers and polyurethane adhesives and on the characterization of the adhesive/ tie-layer-degrading enzymes to resist at environmental stress. She is also involved in the evaluation of enzymes protection and triggering.

GRAZIA TOTARO

Grazia has a degree in Chemistry and a Master's Degree in Science, Technology & Management from the University of Ferrara, as well as a Ph.D in Materials Engineering, University of Bologna. She obtained a scholarship „Spinner 2013" in cooperation with Reagens spa on novel PVC nanocomposites. She was post doc fellow at the same school and she studied new polymer-based nanocomposites from renewable sources and inorganic fillers. She also studied at the laboratoire de Chimie et Biochimie Pharmacologique et Toxicologique (Université Réné Descartes) and was visiting professor at the Ecole Nationale Superieure de Chimie (Clermont Ferrand). Now she is junior researcher at the Department of Civil, Chemical, Environmental and Materials Engineering, University of Bologna. In TERMINUS, she is mainly involved in the characterization of tie layers and polyurethane adhesives and with the enzyme protection and triggering.



SIMONA VARRIALE

Simona graduated in Molecular and Industrial Biotechnology and earned her PhD in Biotechnology at the University of Naples "Federico II", defending the thesis "Development of novel biocatalysts for green chemistry". Her research project was focused on the development of improved biocatalysts for the production of compound with antioxidant activity for the cosmetic industry. She worked as post-doctoral researcher at the Biochemical Process Engineering laboratory at Luleå University of Technology and was involved in the directed evolution of a carbonic anhydrase for CO2 capture processes.

In September 2019, Simona started working at BIOPOX within the TERMINUS project, where she is involved in the production of laccases and the development of bioprocesses for the production of hydrolytic enzymes.

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COMMUNICATION

Plastics Circularity Multiplier

Along with nineteen other projects, TERMINUS is part of the Plastics Circularity Multiplier initiative, with the aim of boosting the efforts of the European Union towards the establishment of a circular plastics economy, which goes hand in hand with the achievement of targets set in the EU Plastics Strategy.

The group will work towards improved communication and synergies among Horizon 2020 and FP7 projects, boosting the impact of these projects and at the same time facilitate the availability of the information for policy makers, industry actors and the general public.

Past Events

International Conference of Lithuanian Society of Chemistry
Vilnius, Lithuania

World Circular Economy Forum
Helsinki, Finland

Chemistry meets Industry and Society (CIS)
Salerno, Italy

Baltic Polymer Symposium 2019
Vilnius, Lithuania

10th International Conference BALTTRIB'2019
Kaunas, Lithuania

Les nouveaux enjeux du recyclage des matières plastiques (Valbree Conference)
Mons, Belgium

TERMINUS webiste provides general information about the project, as well as the latest news and updates on project results.

www.terminus-h2020.eu

More updates can be found on our social media accounts.

@H2020TERMINUS

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STAKEHOLDER ADVISORY BOARD

TERMINUS Stakeholder Advisory Board (SAB) will be tasked with validating and discussing given methodologies, as well as contributing towards dissemination and communication activities, with the aim of promoting the project and its results. Confirmed SAB members include Universal Pack, Consorzio Nazionale per la Raccolta, il Riciclo ed il Recupero degli Imballaggi in Plastica (COREPLA) , The Experimental Station for the Food Preserving Industry (SSICA) and Industrieverband Klebstoffe e.V.

For more information about SAB, please send enquiries to contact@terminus-h2020.eu

CONSORTIUM

TERMINUS consortium is represented by a cross-disciplinary team of renowned organizations from 8 European countries (France, Belgium, Germany, Italy, Switzerland, Norway, Sweden, Lithuania) with expertise in enzyme selection, thermal protection and triggering of enzymes, enzymatic bio-degradation of polymers, UV and water triggered enzymatic activity, formulation of advanced polymers, manufacturing of multi-layer plastic packaging, plastics recycling.

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