D5.4 Publication and/or presentation in International Conferences of the chemoenzymatic re- or upcycling PLA or PET

A series of dissemination activities were conducted to communicate the chemoenzymatic re- or upcycling of PLA or PET, targeting the diverse scientific audiences through posters and peer-reviewed publication.

Poster Presentations

- **Polymers for a Safe and Sustainable Future,** Athens, Greece (28-31 May 2024)

  A poster on «Reviving mixed plastic waste through chemoenzymatic recycling» was presented by Dr. Christina Gkountela in a conference attended by over 100 researchers in the field of polymer material engineering.

Reviving mixed plastic waste through chemoenzymatic recycling

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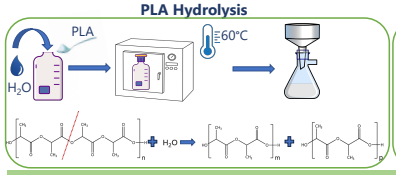
Introduction

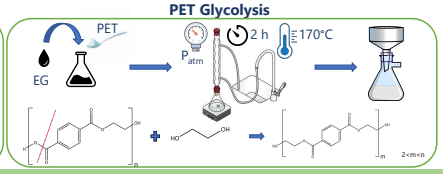
Poor **waste management** worldwide leads to constantly increasing environmental pollution; if current production and waste management trends continue, roughly 12bn tonnes of plastic waste are expected to end up in landfills or the natural environment by 2050. The main obstacle to viable mechanical recycling is the presence of different polymer types in end products (**mixed-plastic waste**), hampering the recycling process and reducing the recyclates' quality (downcycling). The ***EnZyReMix*** project aims to develop innovative methodologies, including **selective enzymatic degradation**, to separate complex packaging waste streams, i.e., mixed plastics, and valorise the depolymerized oligomers from post-consumer materials *via* upcycling approaches. Specifically, we focus on **mixtures of PLA/PET** since PLA is a new source of **polymeric contamination for rPET**, and their separation is not easily feasible due to their similar appearance and densities. In the first part of the research, commercially available PLA and PET grades have been submitted to ***solvolysis*** to prepare oligomers of controlled characteristics, including molecular weight, that will be used as induction media for the secretion of PLA and PET specific enzymes from target fungal strains through proteomics analyses, as well as substrates for co-crystallization studies.

Experimental Part

PLA Hydrolysis

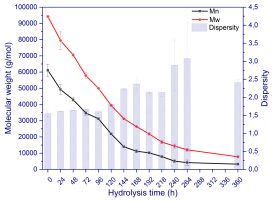


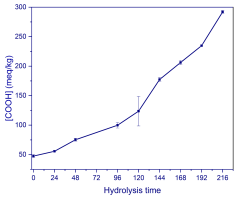
PET Glycolysis



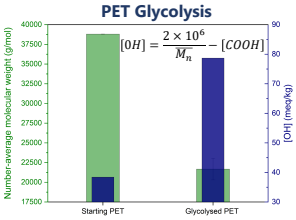
Results and Discussion

PLA Hydrolysis





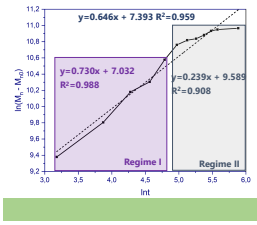
PET Glycolysis



$$[OH] = \frac{2 \times 10^6}{\overline{M_n}} - [COOH]$$

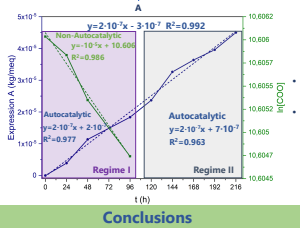
Power-of-the-time model

$$\ln(M_n - M_{n_0}) = \ln\left(\frac{k}{n+1}\right) + (n+1)\cdot\ln t$$



Flory theory-based autocatalytic and non-autocatalytic models

$$\underbrace{\frac{1}{[COO]_0 + [COOH]_0} \cdot \ln\frac{([COOH]_0 + u_t)([COO]_0)}{([COOH]_0)([COO]_0 - u_t)}}_{A} = k_{-} \cdot t \qquad \ln([COO]_t) = \ln([COO]_0) - k_{+} \cdot t$$



Rate constant calculations

k_{mean} [kg/meq·h]	2.06·10⁻⁷± 11%
k_{plot} [kg/meq·h]	2.12·10⁻⁷, R² 0.992
ΔS^2 [(kg/meq·h)²]	1.71·10⁻¹⁷

- **Low values** of the **deviation** between k_{mean} and k_{plot} indicating a **good model fit**.
- The defined rate constant is similar to hydrolysis rate constants derived from **other autocatalytic models** in the **same hydrolysis conditions** (60°C) reported in the open literature:
  - ✓ k_{plot} **2.12·10⁻⁷ kg/meq·h** = **4.10·10⁻³ L/mol·day**
  - ✓ $k_{literature}$ **=7.42·10⁻³ L/mol·day** (Mitchell *et al.* 2014)

Conclusions

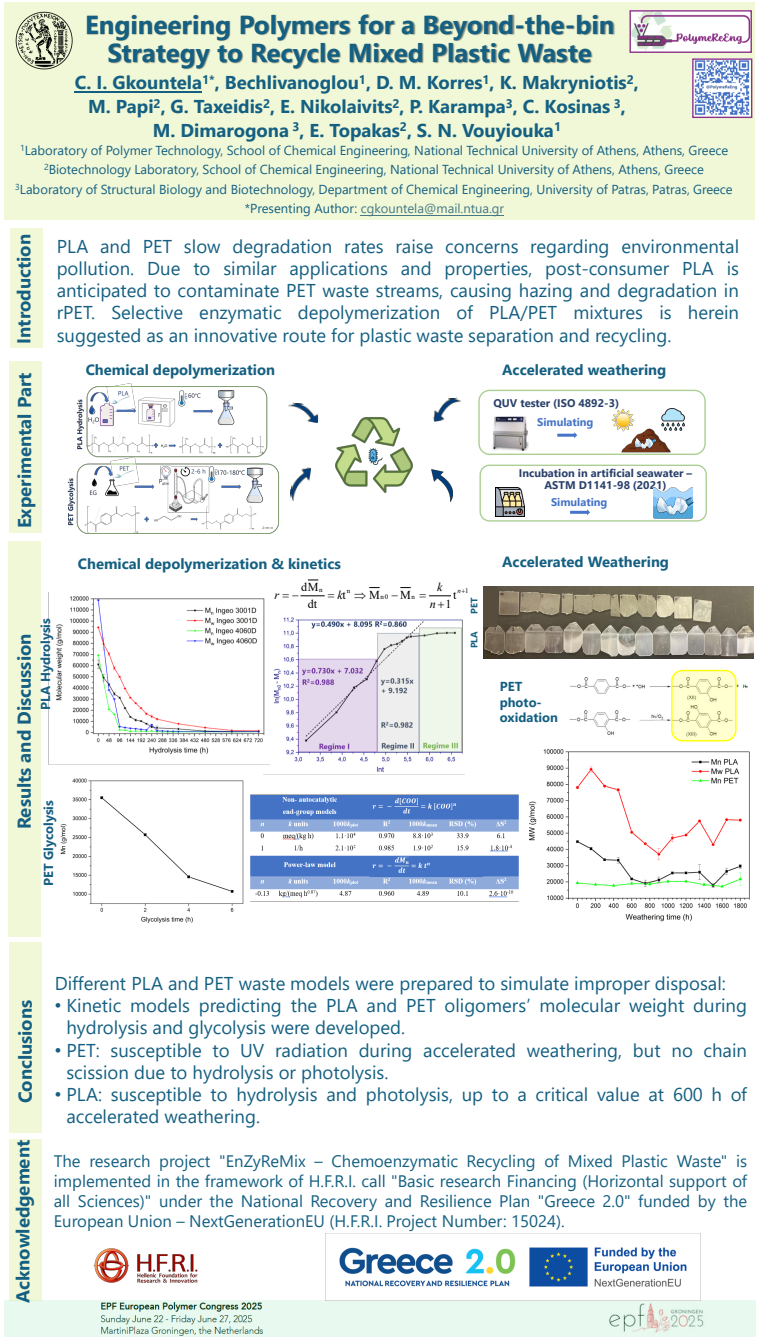
Solvolysis was found effective in producing PLA and PET oligomers for the following plastic-converting enzymes' structure-function relationship studies, and as inducers for Secretomics studies. The fitting of the hydrolysis results to the examined models was found sufficient (R^2 > 0.95) providing a valuable tool to prepare oligomers of controlled characteristics. When submitted to a mild glycolysis process (short reaction time, temperature < 200 °C, no catalyst used) PET presented a significant MW decrease (ca. 45%) and OH-end group concentration increase (ca. 50%).

Acknowledgement

The research project "EnZyReMix – Chemoenzymatic Recycling of Mixed Plastic Waste" is implemented in the framework of H.F.R.I call "Basic research Financing (Horizontal support of all Sciences)" under the National Recovery and Resilience Plan "Greece 2.0" funded by the European Union – NextGenerationEU (H.F.R.I. Project Number: 15024).

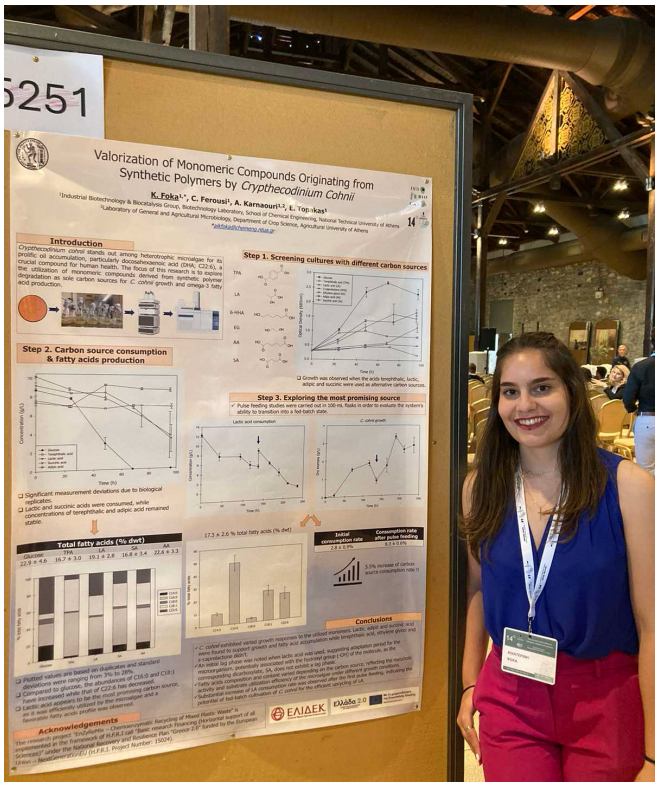
- **EPF European Polymer Congress,** Groningen, the Netherlands (22-27 June 2025)

A poster on «Engineering polymers for a beyond-the-bin strategy to recycle mixed plastic waste» was presented by Dr. Christina Gkountela in a conference attended by over 250 participants from academia and industry in the field of polymer material engineering.



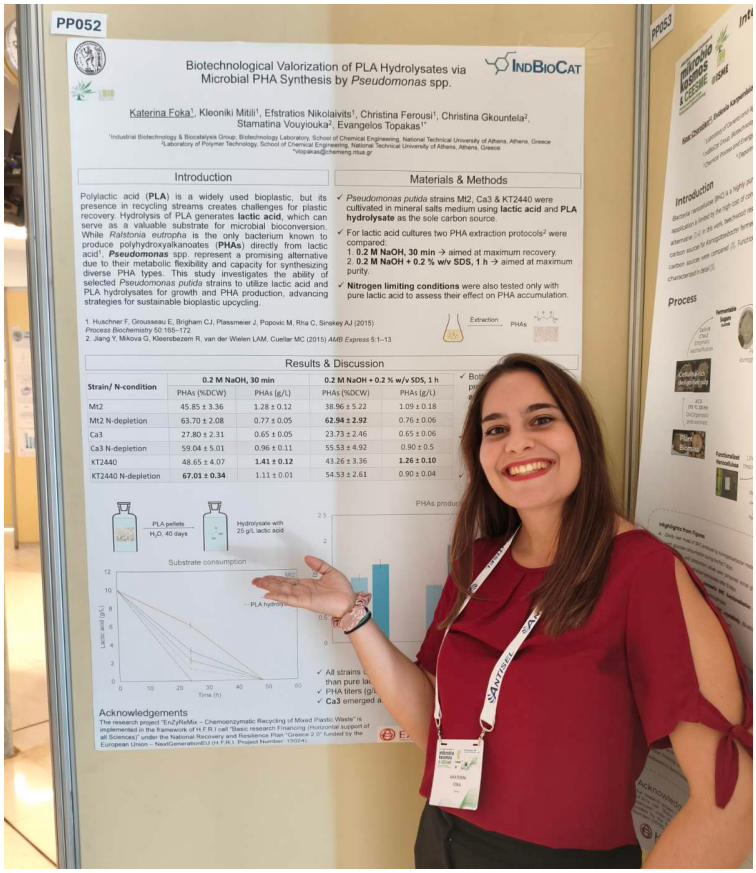
- **14th Panhellenic Scientific Conference of Chemical Engineering,** Thessaloniki, Greece (29-31 May 2024)

  A poster on «Valorization of monomeric compounds originating from synthetic polymers by *Crypthecodinium cohnii*» was presented by Ms. Katerina Foka (PhD candidate) in a conference attended by over 250 participants from academia and industry, related to chemical engineering and biotechnology.



- **Joint International Conference of Mikrobiokosmos & CEESME**, Thessaloniki, Greece (22-24 September 2025)

  A poster on «Biotechnological valorization of PLA hydrolysates via microbial PHA synthesis by *Pseudomonas* spp.» was presented by Ms. Katerina Foka (PhD candidate) to over 200 researchers in the field of microbiology and applied environmental sciences.



Scientific Publication

- **Biotechnology Advances,** online (September 2025)

A review article was published titled «*Polyester-derived monomers as microbial feedstocks: Navigating the landscape of polyester upcycling*» in the journal of Biotechnology Advances (https://doi.org/10.1016/j.biotechadv.2025.108589).

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Volume 82, September 2025, 108589

Polyester-derived monomers as microbial feedstocks: Navigating the landscape of polyester upcycling

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https://doi.org/10.1016/j.biotechadv.2025.108589 ↗

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