Polymer characterization of blends for 3D printing

Internship proposition at the ERPI Laboratory 2026 - 2027

Table 1: Overview of the internship at the ERPI Laboratory

Project	**UP3DCYCLING**
Profile	Student Master M2 on Chemical engineering with focus on 3D printing.
Key competences	Polymer science, experimental characterization, data analysis
Languages	French and English
Salary	Gratification grid for internships at the Université de Lorraine
Tutors	MCF Fabio A. Cruz Sanchez (ERPI) PhD. Catalina Suescun Gonzalez (ERPI)
Place	Laboratoire ERPI (Equipe de Recherche sur les Processus Innovatifs) – 8 rue Bastien Lepage, 54000 Nancy, France
Period	Feb/March - August 2027 – 6 months
More Information	fabio.cruz[at]univ-lorraine.fr – suescung1[at]univ-lorraine.fr – (https://up3dcycling.fr/)

1 Context of the Internship

The internship takes place at the Équipe de Recherche sur les Processus Innovatifs – ERPI (https://erpi.univ-lorraine.fr/), research laboratory of the Université de Lorraine. The ERPI is interested is the the development of methodologies, tools and case studies in the area of innovation process management. Particularly, one of its current areas of focus is on urban manufacturing approaches at the UP3DCYCLING project (https://up3dcycling.fr/), where the main goal scope on the intersection of additive manufacturing, circular economy and urban manufacutirng spaces such as Fablabs, Tiers-places and other manufacturing approaches of the social and solidarity economy.

2 Main Issue

Plastic packaging waste poses an environmental challenge but also represents a potential source of secondary raw materials for additive manufacturing within the framework of distributed recycling via additive manufacturing (DRAM)Kassab et al. (2023). Approximately 12 % of the plastics deposited in recycling bins are rejected at sorting centres in the region of Paris. Of this rejected fraction, films account for roughly 43 %, while pots and trays represent arround 36 %. These packaging formats include polypropylene (PP) and multilayer structures combining polymers such as polyethylene terephthalate (PET) and low-density polyethylene (LDPE). An analysis of 1,190 packaging items using Fourier-transform infrared spectroscopy (FTIR) revealed that 17.4% were made of polypropylene (PP), while multilayer packaging accounted

for 12.5% of the sample. Within the multilayer fraction, approximately 51% consisted of PET/LDPE structures and 4.5% of PP/LDPE structures.(Schmidt et al. 2022). While highly predominant in the packaging the recycling of multilayer remains technically challenging.This as the constituent polymers are often immiscible, which can compromise the properties of the resulting materials. Consequently, these waste streams may be landfilled or incinerated.

Therefore, such packaging represents a relevant feedstock for exploring alternative recycling pathways, including additive manufacturing. Nevertheless, differences in the thermal behaviour, flow properties and interfacial compatibility of the constituent polymers can affect both processing stability and the quality of printed parts.

This internship therefore focuses on recycled polyethylene terephthalate (rPET) blended with either recycled polypropylene (rPP) or recycled low-density polyethylene (rLDPE), sourced from plastic packaging. It investigates the use of styrene–ethylene–butylene–styrene (SEBS) as a blend modifier, examining how its concentration and the processing conditions influence blend morphology, printability and the properties of printed parts. A central feature of the project is the direct feeding of the blend components into a fused granular fabrication (FGF) 3D printer called Gigabot XL, without a separate melt-compounding step. This approach raises questions about the printer's ability to melt, mix and deposit the materials consistently, particularly when processing polymers with different thermal and rheological characteristics. A design of experiments (DoE) approach will be used to systematically evaluate the effects of selected printing parameters and their interactions parting from previous work .

The main research question is therefore:

How do blend composition, SEBS content and printing conditions influence mixing quality, printability and the properties of recycled PET/PP and PET/LDPE blends processed directly in an FGF 3D printer?

The project aims to support the valorisation of recycled plastic packaging by identifying formulations and processing conditions suitable for producing printed parts with reproducible properties.

2.1 Objective of the Internship

TThe internship aims to develop and experimentally assess recycled polymer blends for direct pellet-based 3D printing, building on the previous work.

Its specific objectives are:

- Review the previous experimental work and relevant literature to select the polymer system, SEBS grade and initial formulation ranges.
- Develop a design of experiments to assess the effects of the PET/polyolefin ratio and SEBS content on blend processing and printability.
- Evaluate whether direct processing in the Gigabot XL provides sufficient mixing and stable material deposition.
- Investigate the relationships between formulation, printing conditions, blend morphology and printed-part properties.
- Identify promising formulations and processing conditions for further development.

3 Methodology

The methodology will combine a review of previous work, material preparation, experimental design, direct printing trials and characterization.

1. Review of Previous Work and Material Selection

The internship will begin with an analysis of previous work, focusing on the materials, formulations, processing conditions and limitations identified. A targeted literature review will complement this analysis to guide the selection of:

- The blend system: rLDPE/rPP or rPET/rLDPE.
- The polymer composition range.
- The SEBS grade and concentration range.
- The processing variables and characterization methods.

The suitability of the selected SEBS grade for the chosen polymer pair will be assessed rather than assumed. If both blend systems are available, preliminary screening will help determine whether one should be prioritized for the main experimental campaign.

2. Material Preparation and Preliminary Trials

The recycled feedstocks will be documented according to their origin, available composition information and physical form. Material preparation will include size control, removal of identifiable contaminants and appropriate drying. Preliminary trials will establish a feasible processing window for the Gigabot XL. Particular attention will be paid to feeding consistency and extrusion stability. The components will be shredded, clean, and dry before being introduced into the printer.

3.1 Deliverable

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4 Application and Contact

Send the CV and cover letter to:

- MCF Fabio A. Cruz Sanchez (fabio.cruz[at]univ-lorraine.fr)
- Dr. Catalina Suescun Gonzalez (suescung1[at]univ-lorraine.fr)

References

Cruz Sanchez, Fabio A., Hakim Boudaoud, Mauricio Camargo, and Joshua M. Pearce. 2020. "Plastic Recycling in Additive Manufacturing: A Systematic Literature Review and Opportunities for the Circular Economy." *Journal of Cleaner Production* 264 (August): 121602. https://doi.org/10.1016/j.jclepro.2020.121602.

Kassab, Ali, Dawood Al Nabhani, Pravansu Mohanty, Christopher Pannier, and Georges Y. Ayoub. 2023. "Advancing Plastic Recycling: Challenges and Opportunities in the Integration of 3D Printing and Distributed Recycling for a Circular Economy." *Polymers* 15 (19): 3881. https://doi.org/10.3390/polym15193881.

Schmidt, Karolin, Philipp Kösling, Sebastian Bamberg, and Anke Blöbaum. 2022. "A Prospect Theory-Based Experimental Vignette Methodology for Exploring Rebound Effects and Rebound-Damping Interventions." *Ecological Economics* 193 (March): 107302. https://doi.org/10.1016/J.ECOLECON.2021.107302.