VITAL Fact Sheet: Digitally-Optimised Mechanical Recycling of PLA

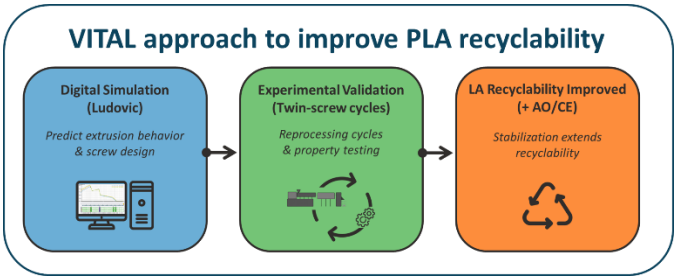
The Challenge

While PLA is one of the most widely used biobased thermoplastics in packaging, its end-of-life recycling remains limited. Unlike fossil-based commodity polymers, PLA shows rapid deterioration when mechanically reprocessed, which hinders its reuse in durable applications. The main barriers include:

- Limited large-scale **availability**;
- Higher **cost**;
- **Processing** difficulties;
- **Performance** limitations in some areas.

Despite these challenges, use of bbTP has clear benefits for reduction of environmental footprint of products, and processes. Furthermore, the anticipated **near-term increase in global production capacity** is expected to mitigate current limitations related to supply and cost.

Within this context, the VITAL project addressed the outstanding challenges associated with material performance and processing. We focused on the development of **lightweight, thermoplastic products**, where foaming is used to reduce raw material consumption. Thermoplastics are also much easier to recycle compared to conventional foamed materials such as thermosets.



Project at a Glance:

Project Name:	**VITAL**
Type:	Research & Innovation Action
Funding:	Horizon Europe CL4 "Twin Transition"
Timeline:	June 2022-Nov 2025
Technology:	Biobased Thermoplastic Foams
Industry Sectors:	Automotive, White Goods, Marine Leisure
No of Partners:	14

The Mechanical Recycling Solution

Experimental work in VITAL identified further technical challenges specific to PLA recycling:

- Noticeable batch-to-batch variability.
- Clear **degradation trends** with reprocessing.
- **Limitations after multiple cycles**, with significant property losses beyond a threshold.
- Higher **sensitivity of foamed PLA** to these challenges.

VITAL developed a **digitally optimised recycling strategy**, combining:

- **Ludovic simulations** to predict extrusion behaviour and define optimised screw profiles.
- **Standard reference screw design** to ensure comparability across cycles.
- **Iterative validation** through thermal, rheological and mechanical testing.
- **Chemical stabilization** to counteract degradation.

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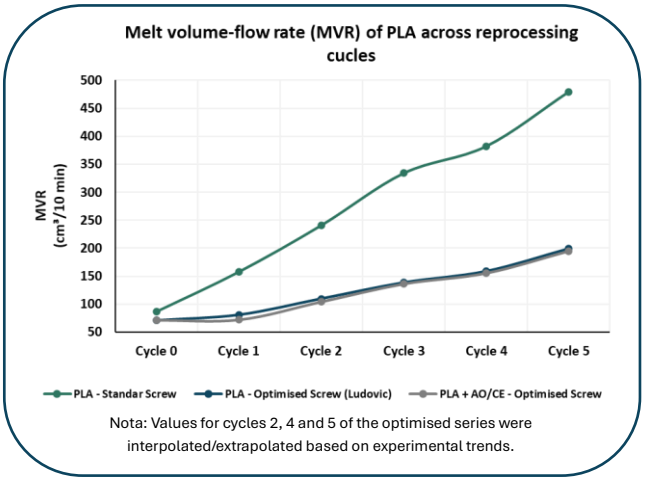
Co-funded by the European Union

Innovate UK

Key Achievements

- Established a comprehensive **database of PLA behaviour** across **multiple recycling cycles**.
- Demonstrated strong correlation between **digital simulations** and experimental extrusion results.
- Identified the **critical recycling limits** for PLA-based foamed materials.
- Proved that **stabilisation can extend recyclability** while maintaining performance.
- Advanced TRL from laboratory studies to pilot-scale validation.



Nota: Values for cycles 2, 4 and 5 of the optimised series were interpolated/extrapolated based on experimental trends.

Benefits & Impacts

Automotive

Lighter parts **improve fuel efficiency and reduce emissions**

Home Appliances

Recyclable, components with reduced material use

- Supports the **circular economy** through improved recycling of PLA.
- Reduces dependence on virgin raw materials.
- Provides industry with **validated digital tools**, **reducing waste** in processing.

Next Steps

- Validate the recycling strategy in **industrial pilot lines.**
- Further assess the **cost–performance balance** of stabilisation systems.
- Disseminate results through various routes.
- Apply the methodology to other biobased thermoplastics.

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