

RECYCLING

Polyolefin Recyclates for Rigid Packaging Applications: The Influence of Input Stream Composition on Recyclate Quality

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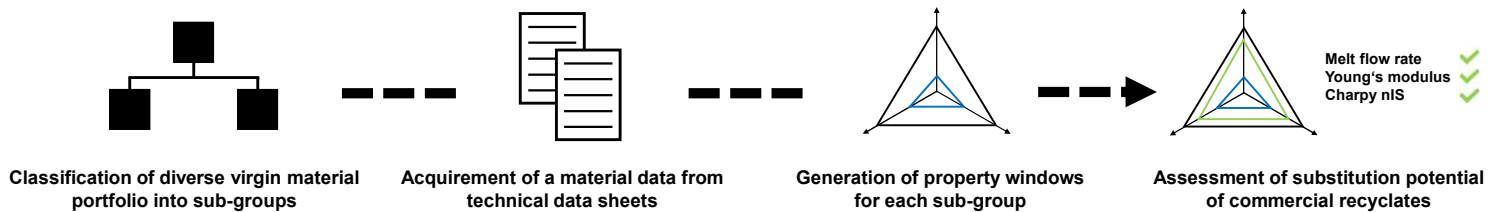
Motivation and objectives

The **quality of recyclates** is a widely discussed topic, since a lack of general definitions and industrial standards prevails. A key quality indicator is the **substitutability** of virgin materials by recyclates, which can be achieved by fulfilling requirements defined by the intended end-use application and the respective processing technology.

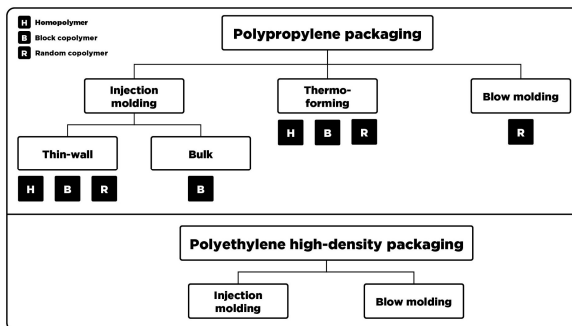
While the overall substitutability is also influenced by economical factors and material availability, this work focuses on a general approach to determine the technical substitutability. Therefore, the **substitution potential for rigid packaging applications** was assessed for commercial **polyolefin recyclates** based on melt flow rate, Young's modulus, and Charpy notched impact strength.

The **sorting step** is considered to have a great influence on recyclate quality, which is why **informal and formal polypropylene and polyethylene high-density recyclates (i/f-rPP; i/f-PE)** were investigated in this work. Informal recyclates are characterized by a manual sorting process leading to a reduced heterogeneity compared to the industrial sorting process that prevails in formal plastics recycling.

Workflow



Virgin material sub-groups



Substitution potential PP recyclates

	IM-TW homo- polymers	IM-TW block copolymers	IM-TW random copolymers	IM-B block copolymers	TF homo- polymers	TF block copolymers	TF random copolymers	BM random copolymers
i-rPP_1	low	low	low	low	high	moderate	moderate	moderate
i-rPP_2	moderate	moderate	moderate	moderate	low	low	low	low
i-rPP_3	low	moderate	moderate	moderate	low	low	low	low
i-rPP_4	low	moderate	moderate	moderate	low	low	low	low
f-rPP_1	low	moderate	moderate	moderate	low	low	low	low
f-rPP_2	low	moderate	moderate	moderate	low	low	low	low
f-rPP_3	low	moderate	moderate	moderate	low	low	low	low
f-rPP_4	low	moderate	moderate	moderate	low	low	low	low

Substitution potential PE-HD recyclates

	IM	BM
i-rPE_1	high	low
i-rPE_2	high	low
i-rPE_3	low	high
i-rPE_4	low	high
f-rPE_1	low	high
f-rPE_2	low	moderate
f-rPE_3	low	moderate
f-rPE_4	low	moderate

Main findings

Lack of formal PP recyclates for:

- Thin-wall injection molding applications with high stiffness.
- Thermoforming and blow molding applications.

Lack of formal PE-HD recyclates for:

- Injection molding applications.

Input stream composition affects recyclate quality

- Homogeneous input stream retains initial material properties.
- Formal PP input stream consists of a mix of various significantly different grades, which prevents the suitability for many applications.

Outlook

- Importance of high-quality recyclates is highlighted by legal framework for a circular economy (e.g., mandatory recyclate content).
- Holistic application-specific property windows must be developed by expanding the set of parameters (e.g., color, migration levels) to adequately assess the substitutability.
- Functional recycling shall be pursued within the economical and ecological boundaries.



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