Getting flexible to drive circularity from mixed polyolefin post-consumer waste

Designing to maximize the scope of use for r-PE in flexible packaging

High quality flow wrap wet wipe pouches made using r-PE from unsorted post-consumer flexible waste

Drivers

The EU's target of 10 Mtonnes recycled plastics in the marketplace by 2025 has elicited widespread commitments from public and private actors in European plastics value chains. In 2018 Multicycle partner AMCOR pledged that all their packaging would be recyclable or reusable by 2025, through a focus on design for recycling, implementing high recyclate content in products, and collaboration along the value chain for systemic change. The MultiCycle approach aligns with these priorities and is a potential route to overcome the current limitation of recyclates from mechanical recycling to injection moulding grades, which cannot go into flexible packaging.

This case study looks at the evaluation of MultiCycle post-consumer waste derived polyethylene recyclates (r-pc-PE) in typically used packaging formats for home and personal care applications, most particularly in flow wraps for wet wipes.

Approach

r-pc-PE was produced from representative mixed-polyolefinic post-consumer waste (ex-Meilo GmbH & Co. KG.) treated in the the MultiCycle integrated industrial pilot plant at LOEMI GmbH. From an analysis of the physical, mechanical and chemical properties of this material and exploratory experimentation relative to virgin material counterparts carried out by Fraunhofer IVV and AMCOR, novel packaging structures for flexible packaging applications were defined and designed.

Key Features

- Successful demonstration of a stable process for high r-PE based flexible film production
- First time demonstrated use of recyclates sourced from co-mingled, printed flexibles from household municipal waste without special pre-sorting
- Promising preliminary results for the appearance and aesthetics of printed flow wrap product mock-ups

Processability into blown-films was evaluated in a stepwise fashion, sequentially moving from small-scale monoline trials at 50% and then 100% r-polymer content through to larger pilot line trials of full multilayer packaging film structures.

Finally packaging product mock-ups have been produced at craft scale from the resultant multilayer films, allowing a preliminary evaluation to be made of factors such as printability and product appearance for designs incorporated the new recyclates.

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Industrial Case Study

Key features of r-PE demonstrators

Material	Melt Flow Rate (g/10min)	T_{melt} (°C)	Density (g/cm³)
r-pc-PE	1.13	124	0.925
Ref.LDPE	1.50	108	0.919
Ref. LLDPE	0.90	124	0.934

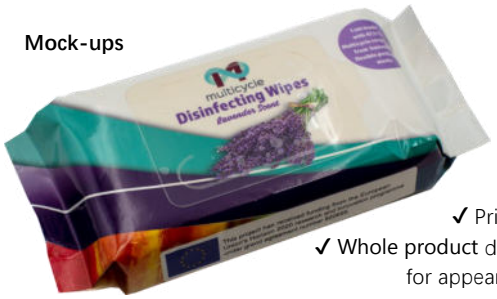
Demonstrator	Structure	Recyclate Content
Flow wrap for wet wipes with chemical resistance	*O*PET//**r-pc-PE**//EVOH//v-PE	39% in sealing film. 28.7% in total laminate
Flow wrap for wet wipes	*O*PP//**r-pc-PE**	72% in PE co-ex sealing film. 47.5% in total laminate.
Stand-up pouch for dry home care	*O*PET//**r-pc-PE**	>85% in total laminate
Flow wrap for wet wipes	**r-pc-PP**//**r-PC-PE**	72% in PE co-ex sealing film. TBC in total laminate

Monolayer blown film rolls with (top to bottom) 100% virgin, 50% r-PE and100% r-PE content

Film Properties relative to virgin

✓ Mechanical (modulus, tensile strength, breakage etc.)
≠ Optical (colour, haze)
✓ Oxygen / water vapour permeation
≠ Sealing curve

Mock-ups



✓ Printing
✓ Whole product design for appearance

MultiCycle has enabled demonstration across a range of applications, formulations and designs reflective of typical marketplace requirements

Results and Benefits

Following successful processing into monolayer blown film using similar conditions to virgin PE, four r-pc-PE containing multilayer designs were prioritised for further evaluation. Of these, three have been executed at large pilot scale, with a fourth being evaluated at lab scale. The first demonstrator is a chemically resistant flow wrap for disinfecting wipes, consisting of an oriented PET outer film for stiffness and printability and a coextruded r-PE/EVOH/v-PE film with a sealing layer on the inside. A second flow wrap demonstrator, applicable where chemical resistance is not needed, features an oriented PP/r-pc-PE structure. The third design is for a stand-up pouch for dry home care (detergent tabs) and the fourth is a further flow wrap including r-PP as well as r-PE.

The overall properties profile of r-PP indicated that it would be most readily incorporated in bulk and internal layers of multilayer structures, where they can substitute for a relatively large proportion of virgin materials. More specialist, functional layers (e.g. for sealing or heat resistance) require very narrowly specified materials and hence tend to favour primary sourced materials.

The major benefit of a commercialized MultiCycle approach would be to open up the supply of recyclates. Current mechanical recycling of PE relies upon a high degree of waste selection and presorting to achieve packaging grade specifications and so supply is limited. The MultiCycle approach should enable recyclers to target printed, co-mingled household waste without special sorting, driving recycling rates upwards.

Further Steps

To date processing has been at pilot plant scale. The next technical step will be to look at full commercial line speed laminate production. Looking towards the transition to full scale operations will require an implementation team including investors and operators to work with Fraunhofer and LOEMI to prepare the decisions for investment, sites and timings.

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SPIRE PROJECT

In line with the ambition for a Circular Economy in Plastics, MultiCycle has delivered an industrial recycling pilot plant for multilayer flexible packaging and fibre reinforced thermoplastic composites using a novel selective dissolution process to recover pure single polymers suitable for processing back into the value-added applications from which they arose.

Advanced and sustainable recycling processes and value chains for plastic-based multi-materials

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