Pocketing the benefits: recyclate-based staple fibres in an aesthetic nonwoven form

New possibilities for high value recycling of PET from mixed sources

r-PET from multimaterial waste used in composite nonwovens for an aesthetic vehicle interior part

Drivers

Plastics are now established as a vital contributor to modern automotive design, variously providing features of vehicle safety, functionality, aesthetics, and more, all from materials offering a uniquely attractive combination of function to weight in many applications. The desire to maximise the use of sustainable materials, and trends towards hybrid and battery electric vehicles emphasise the importance of new materials and weight optimization in vehicle design, however the limitations on end of life feedstocks suitable for mechanical recycling currently constrain the supply of sufficiently high grade recyclates. If we can overcome these constraints the opportunity is to more broadly *retain and cycle back the value* designed into plastics and avoid consuming further petrochemicals in making more virgin materials.

The door panel pocket is an example of an aesthetically important vehicle interior part where thermoplastic-based nonwovens provide an alternative to natural fibre inserts. Staple PET/PP fibres are laid in a non-woven mat, pre-consolidated into sheets and thermally formed into the final part (pocket) shape, suitable for installation on the vehicle. Circularly sourced thermoplastic recyclates need to be suitable for substitution into this manufacturing chain with minimal alteration to line set-ups and conditions, and deliver equivalent product form and aesthetics in order to be competitive with virgin materials.

Approach

Recycled PET (r-PET) obtained as a single polymer stream from flexible packaging multilayer waste

Key Features

- Successful production of r-PET suitable for staple fibre production from non-single source plastic waste at industrial pilot scale by low intensity, selective solvent-based physical separation without the need for depolymerisation
- Resultant r-PET staple fibres successfully introduced into near-normal processes for the manufacture of pre-consolidated composite nonwoven sheet and forming of an aesthetic vehicle interior part.

feedstock treated though the MultiCycle industrial pilot demonstration facility operated by LOEMI has been processed end to end from fibre spinning to final part form. Staple r-PET fibres produced by SILON s.r.o. have been converted, along with virgin polypropylene, into nonwovens by Gen 2 Carbon, then formed into pre-consolidated sheets by Bond Laminates, and thermo-formed into door panel pockets by Farplas Otomotiv, for final evaluation by Stellantis TOFAS.

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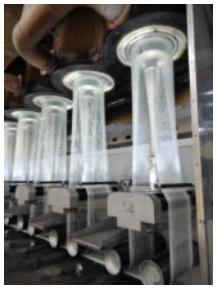
Industrial Case Study

From fibre to form - results

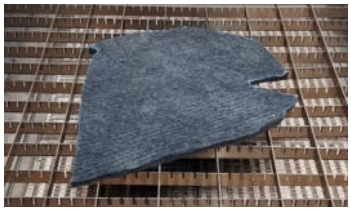


Melt spinning of MultiCycle r-PET

Property	Ref. Fibre	MultiCycle
Tensile Strength (cN/dtex)	3.4	3.1—3.3
Elongation (%)	88	80—96
Linear weight (dtex)	6.6	6.3—6.7

Nonwovens with r-PET / PP

Property	650gsm grade	1000gsm grade
Mass (g/m^2)	665	1194
Thickness (mm)	4.5	5.6
Tensile Strength (N) [one way / right angle]	1140 / 695	2066 / 1081
Dimensional Stability (%)	0.3 - positive	0.4 - positive
Odour / Rot Resistance	No unpleasant odours	No unpleasant odours
Burn Rate (mm/min)	68	35



Door Panel Pocket

- ✓ Nonwovens preconsolidation finalized
- ✓ Processing trials conducted
- ✓ Injection molding modifications completed to take account of nonwoven specifications

Two nonwoven grades were targeted using r-PET fibres with subsequent thermoforming into the door pocket product form

Results and Benefits

r-PET was recovered from the MultiCycle process directly as a fine solid for which most properties (melting point, viscosity, moisture and dust content) were well within SILON's process requirements. Bulk density was the main point of difference, being much lower than even conventional mechanically recycled "bottle flake" PET. In principle however, r-PET could be readily pelletized by a conventional melt pelletization step (which was not within the scope of the implemented pilot plant). In practice, with appropriate adjustment of dosing channels, several samples were successfully spun into fibres, with properties comparable to a virgin PET reference grade, and final material conforming to product requirements.

The subsequent composite non-woven production and pre-consolidation steps were successfully completed. Two grades of non-woven were targeted, at 650 gsm and 1000 gsm density respectively, and following preliminary processing trials at Farplas, suitable injection moulding modifications were identified to reflect the characteristics of the nonwovens produced.

The MultiCycle approach has shown the potential to produce r-PET from mixed and multimaterial streams with close to virgin material and processing properties sufficient for ready substitution into the manufacturing chain. This opens up the prospect of greatly broadening the scope of supply for r-PET and thus substantially enhancing the availability of high quality recyclate based grades in the market place.

Further Steps

Further evaluation of the final door pocket panel form is ongoing. Looking further ahead, it would be desirable to extend the scope of source from which recyclates are derived to include directly cyclical reapplication of automotive sourced r-PET and to establish quality stability and tolerance limits for recycled content over multiple recovery cycles.

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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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