New life for old composites: a circular materials loop for car battery trays

Retaining the value of PP and PA in automotive scrap

A whole value chain collaboration to demonstrate circularity in a thermoplastic composite based functional automotive part

Drivers

For automotive OEMs the desire to maximise the use of sustainable materials, and trends towards hybrids and battery electric vehicles reinforce the ongoing importance of new materials and weight optimization in vehicle design. With plastics making up half or more of a typical car by volume but just 10% by weight, the attractions of sourcing materials that simultaneously minimise the use of petrochemical feedstocks and address end of life challenges are evident.

This case study looks at the use of circular plastics in the production of a car battery carrier (tray) for internal combustion engine driven vehicles. This is a functional part housed within the confines of the vehicle engine compartment, where adherence to dimensional tolerances and stability are of prime importance. In order to successfully deliver these requirements without sacrificing competitiveness, circularly sourced plastics alternatives need to be suitable for substitution in the manufacturing supply chain (Tier 2, 1 and OEM) with minimal alteration to line set-ups and conditions, and deliver equivalent performance across a range of component and functional tests.

Approach

Two versions of a complex geometry based battery carrier with an L-shape organosheet reinforcement have been produced, based respectively upon glass fibre reinforced r-polyamide (r-PA) and r-polypropylene (r-PP) recovered by the MultiCycle Creasolve® process demonstrator. Customized composites specialist Bond Laminates has assessed sheet laminate grade thermoplastic materials for their mechanical properties at various levels of recyclate inclusion, and used them to produce organosheet laminates, which are subsequently cut to the required reinforcement part shape. The carrier form has been produced by Farplas Otomotiv in versions incorporating both recycled and virgin materials, using an automated robotic hybrid composite injection moulding process (FiberForm, KraussMaffei), for final evaluation in application by Stellantis TOFAS.

Key Features

- r-PP and r-PA produced in sheet laminate and injection suitable grades from waste plastics sources at industrial pilot scale via low intensity, selective solvent-based physical separation without the need for depolymerization
- Straightforward substitution of recyclate based formulations into sheet laminate and hybrid composite injection molding processes without sacrificing processability or properties.

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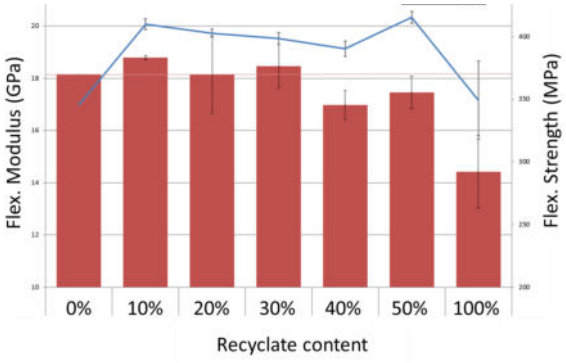
Industrial Case Study

Key tests and results

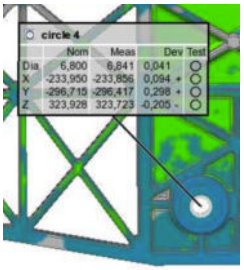
MultiCycle r-PP with v-PP plus endless glass fibres (RG600 roving glass with 600gsm)



Cut organosheet part with 30% r-PP

✓ Appearance
✓ Mechanics

Battery Carrier



✓ Processing parameters
✓ CMM measurements

Component and Functional Tests

Environmental requirements
Dimensional requirements
Appearance requirements
Moulding check
Vibrational Thermal Fatigue on vehicle

MultiCycle PP and PA recyclates can be formulated at up to 30% without sacrificing either processability or resultant performance

Results and Benefits

r-PP inclusion at up to 30% delivered similar composite mechanical properties to the virgin injection-grade PP pellet only baseline. Higher recyclate contents (up to 50-70 %) are possible, albeit with a some loss of mechanical properties.

Organosheet has been successfully produced with either 30% r-PA or 30% r-PP with no process adaptations necessary. Subsequent product appearance, mechanical and haptic (touch-related) properties were effectively identical to virgin polymer based versions, and the laminates were cut successfully to the required part shape.

The r-PP battery carrier has been successfully formed, with virtually the same forming process parameters to those used when virgin-based material is used in the forming process. Evaluation of a range of critical part dimensions (CMM coordinate measurements) demonstrated that there was no significant deviation from nominal values.

Future benefits could ultimately be realised across the value chain. For materials or component suppliers there would be opportunities to establish credible claims for more sustainable product grades. End users could demonstrate progress towards environmental goals and fulfilling producer responsibility obligations. Those dealing with end of life materials management could benefit from access to a new route to recoverable value from lightweight plastic fractions for which current mechanical recycling systems offer no solution.

Further Steps

With work on the r-PA based version ongoing and full evaluation of the battery carrier for both types underway in an extensive range of stability and functional tests, the MultiCycle approach is being thoroughly validated in the envisaged use case. Longer term, the focus of the sorting infrastructure around end of life vehicles will need to shift towards retaining the value embedded in engineered plastics.

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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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