

Development of New Recycled Materials from Multilayer PET Packaging Waste for Footwear, Toy and Building Applications

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Abstract

Multilayer PET (mPET) recycling is hampered due to their heterogeneity and the lack of compatibility among layers [1,2]. Mechanical recycling methods consider the separation of the layers, thus making the process challenging and expensive. Chemical recycling is also demanding and could have an environmental negative impact on the planet. Currently more than 3.3 million tons of plastic waste coming from packaging are disposed of in landfill sites, from which 800.000 tones within Europe are multilayer PET [3]. On the other hand, the European Commission raises the need for quadrupling recycling capacity for plastic in Europe by 2030. The Technological Institute for Children Products & Leisure (by its Spanish Acronym AIJU) and the Polytechnic University of Valencia (by its Spanish Acronym UPV) have created a mechanical recycling system for this waste valorization [4]. They have jointly patented this process and are developing an innovation project to use it in applications such as building, toys and footwear.

Keywords: Multilayer PET; Recycling; Polyolefins competition; Building; Footwear; Toys

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Introduction

A new processing technology allows the mechanical recycling of multilayer packaging with high PET content in its composition (more than 50wt%), without having to separate the layers from each other but by compatibility blending. As a result, a new recycled polyolefin-based material is achieved, through extrusion-compounding, in the form of pellets with good mechanical and thermal properties and at a highly competitive price. The new material is used as polyolefin recycled alternatives of PE, PP and their copolymers, which are commodities highly demanded within the market. As a consequence, the new recycled compound will be broadly used in consumer and industrial sectors that currently use those types of materials (toy, construction, household products, footwear, automotive, etc.). In order to check its replicability at industrial level a new project is being developed for the achievement of new formulations of recycled material based on multilayer PET (mPET) and polyolefins, in the form of pellets, processable by extrusion, injection and lamination. These new formulations will have suitable mechanical and thermal properties for use in industrial applications within the construction, footwear and toy sectors. To meet these very specific technical characteristics, the materials obtained must be formulated. The demonstrators achieved will be evaluated in relevant environments to demonstrate their viability.

Setting Research Basis for R&D Research

Multilayer PET waste streams and their conditioning

The identification of the multilayer PET packaging waste stream both post consumption and industrial waste are already made in the project considering the intended region. The

aim is, on the one hand, to characterise the different fractions to obtain the technical specification and, on other hand, to condition the materials through specific processes of the multilayer fraction so that it can be processed later.

Requirements per application

The requirements to obtain the new recycled pellets on a pilot-semi-industrial scale are also specified. They meet the specifications of the intended applications: components for footwear, toys and waterproofing laminates for construction.

Next Steps

Previous steps are the ones required to start the development of the new mPET recycled materials. From there, the research is now starting the following stages:

- a. Development, characterisation and optimisation of the new materials on a lab/pilot scale
- b. Scaling and optimisation of recycled mPET pellets. Formulations for industrial demonstrators by mixing with the polymeric materials currently used in high amounts.
- c. Industrial validation of both, the new formulations developed and the prototypes in the real environment.

The final results of the project will be:

- I. A novel recycling process validated both on a pilot scale and by recycling companies that allows the recovery of multilayer rigid packaging with a high content of PET in its composition (>50-60%) without the need to separate the different layers of the material.
- II. New formulations of recycled material in the form of pellets based on mPET and polyolefins, in the form of pellets, processable by extrusion, injection and laminating, current technologies used by companies.
- III. Formulations validated by obtaining prototypes of footwear components (reinforcements and bumpers), waterproofing membranes for construction, both interior and exterior, and toy parts (for example, tricycle-type vehicle parts) made with recycled mPET material.

This validation will be carried out through the use tests in a real environment to demonstrate that they meet the high technical requirements of the products.

Conclusion

The aim of this initiative is to minimize up to 90% the amount of mPET packaging waste that goes to landfill or incineration, giving them a new use for high value-added products manufactured in the Valencian Community. This work will be carried out at the laboratory level in collaboration with the UPV and AIJU and a completely characterized material will be obtained to be used in industrial tests in relevant environments with the companies IBERRESINAS, REVESTTECH, participants in the consortium. Participating companies will verify their potential use on an industrial scale to obtain different non-marketable prototype products for prior validation before putting them on the market. The results can be transferred to various sectors other than those that will be validated in the project, both in consumer product sectors and technical products that currently use recycled polymers (automotive, packaging, kitchenware, etc.). Companies that are dedicated to the recycling of plastics and the sale of recycled compounds will also be able to use this technology to formulate and industrialize new compounds, thus enabling them to develop tailor-made mixtures for their clients. Companies in the food sector that use multilayer sheets with PET for the packaging of their products belong to one of the main sectors interested in this invention, since by 2030 they are obliged to use recyclable materials, which is that with the development carried out, it is covered without the need to change the nature and benefits of the materials currently used.

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