Influence of the recycling in the mechanical and thermal properties of post-consumer polypropylene materials used as bumpers of cars

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Key words:

Introduction

The large amount of waste currently produced by the society is a serious environmental problem. Recycling is presented as a way to reduce waste. The fact that plastics are organic matter that degraded by oxidation during use and when they are subjected to high temperatures and shear forces during processing, may explain the limited use of recycled plastics. It is therefore necessary further knowledge of the properties of recycled plastics in order to find appropriate applications and thus increase the use of these materials.

The polypropylene (PP) is one of the most widely used plastics and maintains its mechanical properties after undergoing successive recycled. One of the most interesting properties of polypropylene is its good recycling behavior as it maintains its mechanical properties such as impact strength, modulus of elasticity and thermal after undergoing extrusions and repeated injections. According to several authors [1], after these processes only properties fell by 4.4% and the index carbonyl remains virtually unchanged .

OBJETIVE

The main objective of this work is to evaluate the changes that occur in the mechanical and thermal properties of polypropylene used as bumpers of cars after several mechanical recycling cycles consisting of alternating cycles of grinding, extrusion and injection. A comparative study is made with the results of the virgin polypropylene.

Experimental Procedure

The post-consumer polypropylene was from parts of cars. The recycling cycle consisted in grinding, extrusion and injection (Fig.1), obtaining different test samples (PPpc1) according to the UNE-EN standards (Fig.2). After analyze them, the test samples were recycled for two and three times (PPpc2 and PPpc3). In order to investigate the influence of the recycling cycles on the material, the mechanical properties were studied by tensile testing according to UNE-EN-ISO-527 standard and Impact test (UNE-EN-ISO-179). Vicat Softening temperature (VST) test (UNE-EN-ISO-306) and Differential Scanning Calorimetry (DSC) were also performed. Figure 3 shows the experimental procedure.

Figure 1: Grinding-extrusion-injetion line

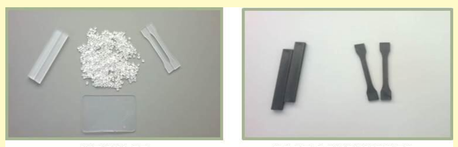


Figure 2: Test samples

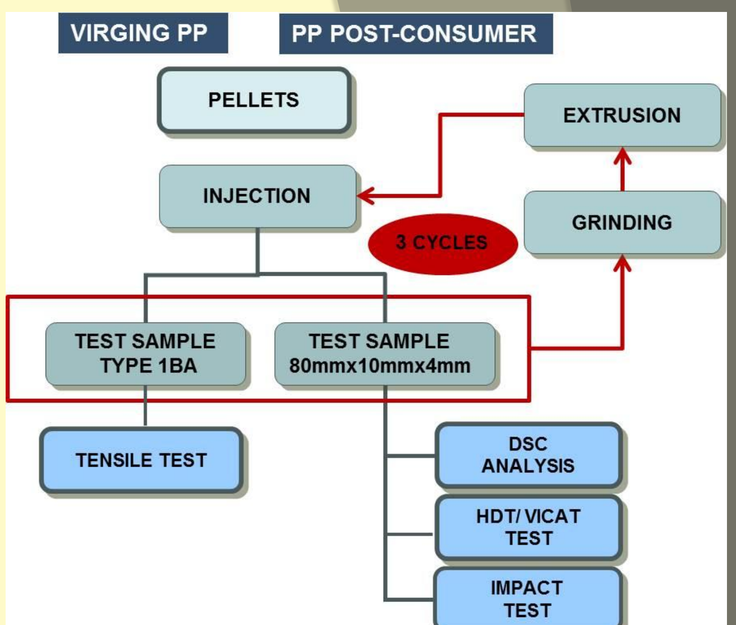
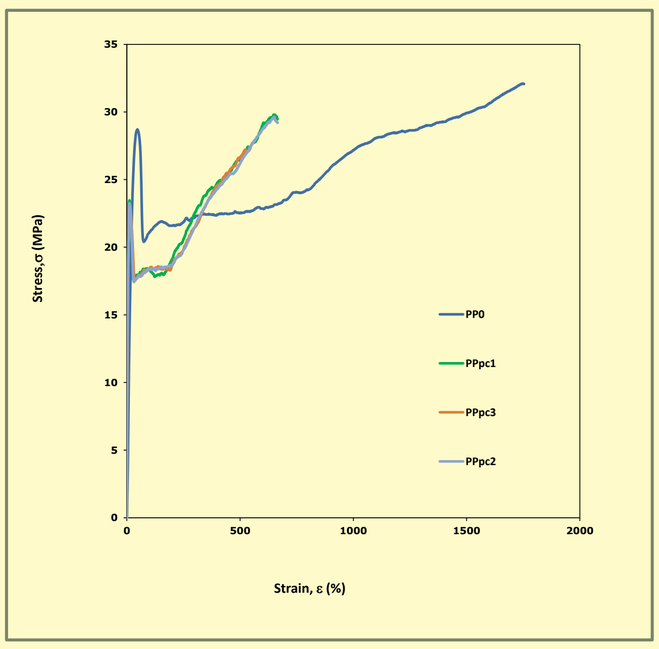


Figure 3: Experimental procedure

Results and Discussion

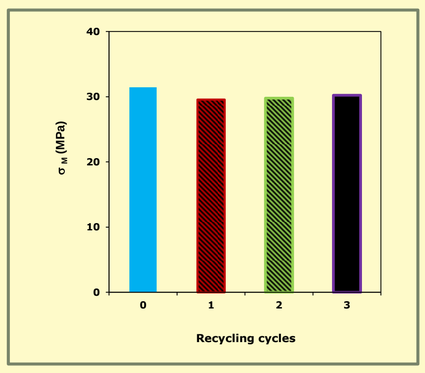
Mechanical properties



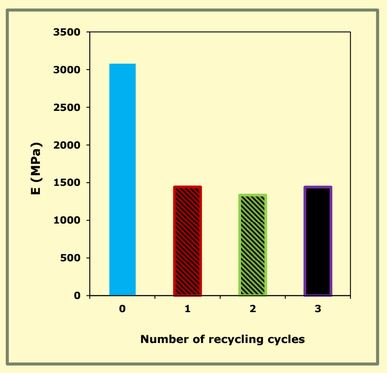
Most of the mechanical properties of the post-consumer polypropylene decrease after recycling compared to virgin polypropylene During simulated recycling the mechanical properties (elongation-at-break, yield stress and Young's Modulus) dropped initially and increased again upon second and third recycling cycle. However, impact strength showed opposite behavior.

This zig-zag behavior is probably explained by a combination of three mechanisms: (1) changes in degree of crystallinity, (2) surface degradation, and (3) dilution of degraded polymer chains after re-extrusion.

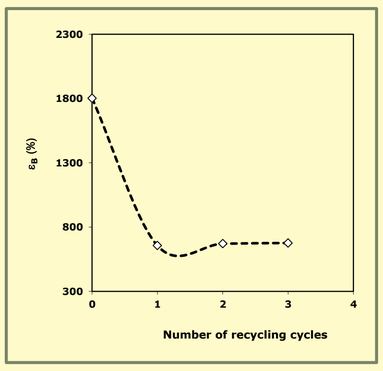
Yield stress



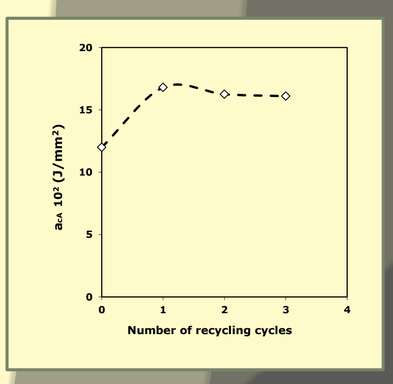
Young's Modulus



Elongation-at break

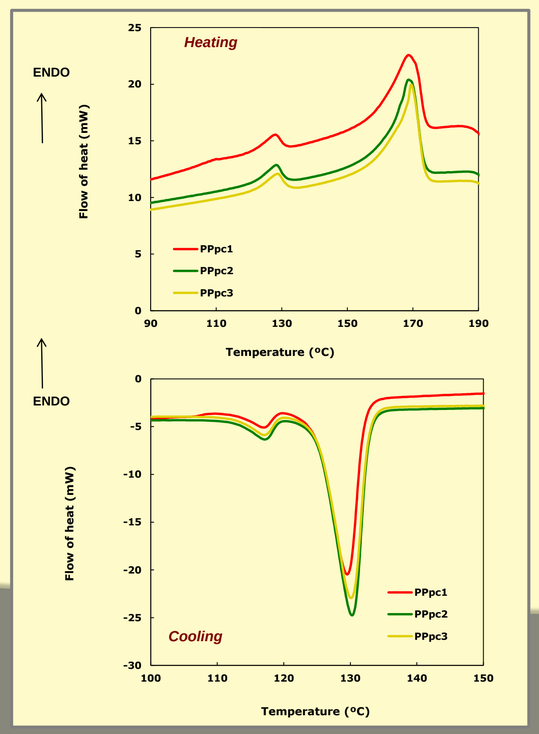


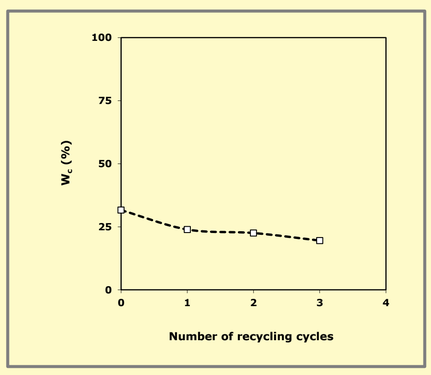
Impact Strength

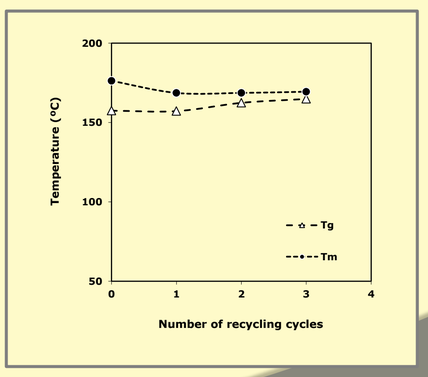


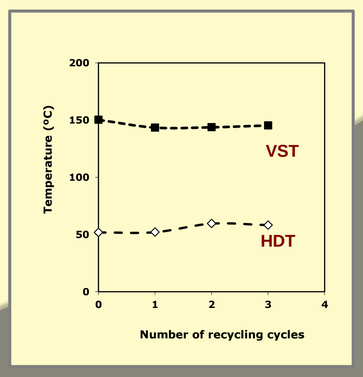
Thermal properties

DSC heating scans were performed to determine the influence of the recycling cycles on the thermal behavior and crystallinity of the PP post-consumer. The melting temperature values (T_m) increased and crystallinity index (W_c) for the studied samples diminished after recycling. Vicat and HDT temperatures showed slightly variation.









Conclusions

Post-consumer recycled PP has lower mechanical properties than virgin PP. Hoewever, after several recycling cycles maintains the mechanical and thermal properties.

Acknowledgment

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