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Newsletter Elasto-Plast

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In this newsletter

Contact us

https://interreg-elastoplast.eu/

as@centexbel.be

ids@centexbel.be

sco@centexbel.be

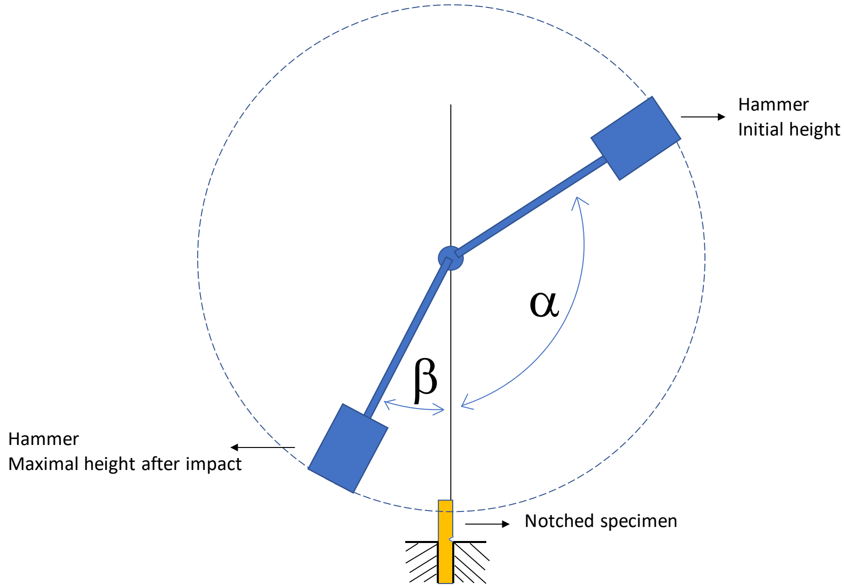
Use of TPE to improve the impact resistance of traditional thermoplastic polymers

In the scope of the Elasto-Plast project, we are particularly interested in using thermoplastic elastomers (TPE) to improve properties of traditional thermoplastic polymers.

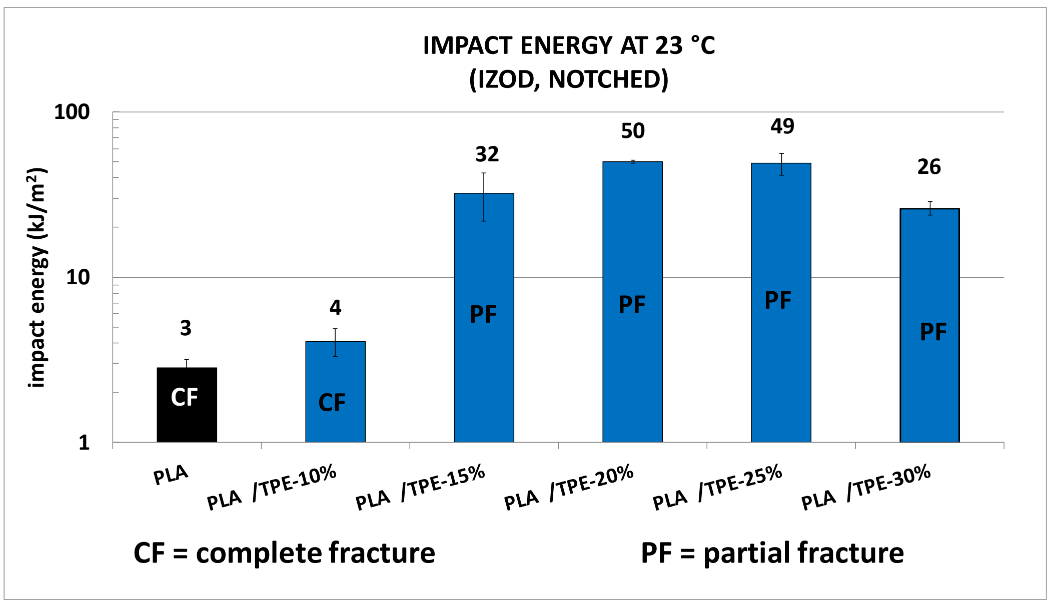
For example, we have blended polylactide (PLA), a biobased and biodegradable thermoplastic polymer, with a block copolymer (TPE), whose structure is composed of polyether soft blocks and aromatic polyester hard blocks. This TPE has a hardness of 30 shore D. The combination of these polymers aims at improving the impact resistance of polylactide, which is weak.

Consequently, PLA/TPE blends were prepared by extrusion. The weight percentage of TPE was varied from 10 to 30%. Extrusion temperatures were between 190°C and 210°C. Rectangular specimen of the blends were made by compression molding in order to measure impact resistance of materials.

Impact resistance measurement is performed using a pendulum-type hammer using ASTM D256-10(2018). A hammer with a mass of 0,668 kg is dropped from a certain height. At a speed of 3,46 m/s the hammer hits the notched sample, which is clamped in a support. The kinetic energy of the hammer at the time of the impact is 4 J. During the impact, the sample breaks completely or partially depending on the toughness of the material and absorbs a part of the hammer's kinetic energy. This absorbed energy is measured. The energy absorbed by the sample divided by the cross section under the notch of the specimen corresponds to the impact energy (IE) of the material and is expressed in kJ/m^2. The higher this value is, the higher impact resistant is. The following figure shows a schematic representation of the test procedure.



The influence of the TPE-ratio in the blends on impact energy is presented in the following figure. 100%PLA and the blend with 10% of TPE show a low impact energy. A complete fracture of the samples is observed. On the other hand, for blends with more than 15% of TPE, partial fractures of samples are observed, and the impact energy increases considerably to a maximum value of 50 kJ/m^2 for the blend with 20% of TPE. For the latter, the impact energy is equal to approximately 18 times that of 100%PLA.



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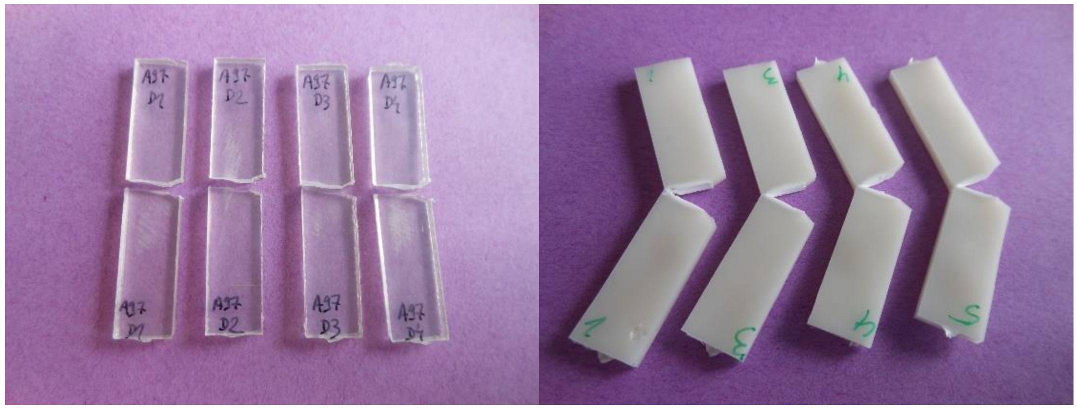
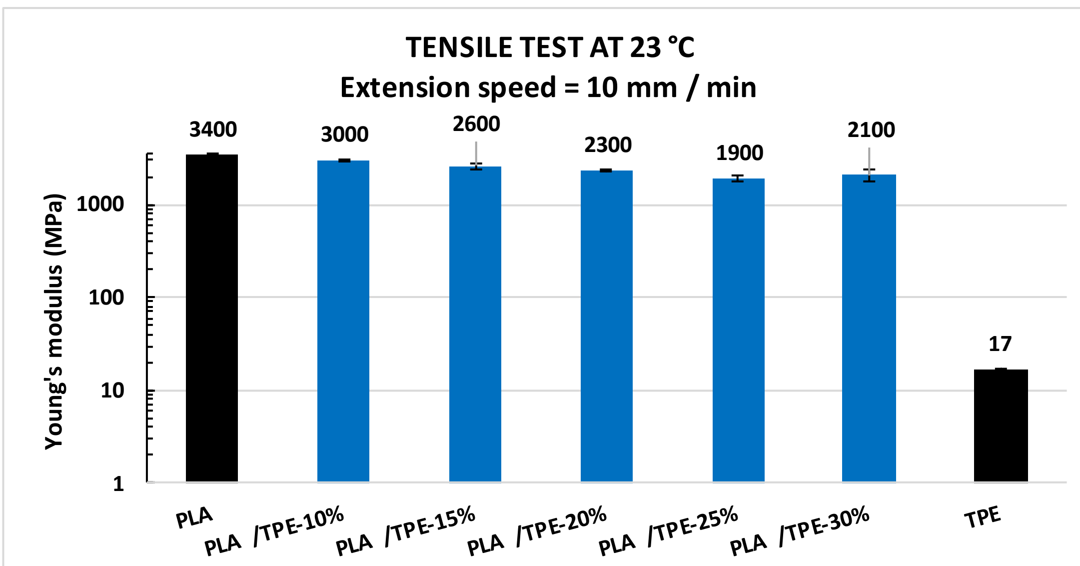
Photos below show 100% PLA and PLA / TPE-20% specimens after the impact test. The complete fracture of the PLA samples and the incomplete fracture of the blends are clearly observed. It is also observed that the PLA is transparent while the blend is an opaque material of whitish color.



PLA **PLA / TPE-20%**

We also carried out tensile tests on dumbbell-shaped specimen, also produced via compression molded. These tensile tests particularly allow to measure the Young's modulus of materials, which indicates the stiffness of the material. The higher the Young's modulus is, the stiffer the material is.



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The influence of TPE content in the blends on Young's modulus is presented in the previous figure. We can observe that stiffness of the blends, although containing a very soft material (TPE), does not undergo a significant decrease, compared to that of PLA.

This study therefore shows the results of new materials, composed of PLA and a TPE, whose stiffness is close to that of PLA, and whose impact energies are high compared to that of PLA.

The Elasto-Plast team works with several grades of commercial TPE

In the scope of the Elasto-Plast project, we use many grades of commercial TPE, which we will characterize. The different TPE will be produced in combination with different thermoplastics in order to obtain blends with improved properties. Moreover, the influence of addition of blowing agents will be analyzed. Furthermore, the utility of TPE in different applications, such as 3D-printing, is investigated.

The table, presented below, gives an overview of the commercial TPE and their corresponding families, used in Elasto-Plast.

TPE family	**Grades' commercial names used**
Copolymers with polystyrene blocks (TPS)	Kraton®, Bergaflex™, Badaflex®
Copolymers with polyester blocks (TPC)	Hytrel®
Copolymers with polyamide blocks (TPA)	PEBAX®
Copolymers with polyurethane blocks (TPU)	Elastollan®, Ravathane®
Copolymers with polyolefin blocks (TPO)	Engage™
TPE obtained by dynamic vulcanisation (TPV)	Elastoprene®, Santoprène™, Sarlink®, Alfater^{XL}®

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