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INFLUENCE OF PTFE CONCENTRATION IN PBT ON MECHANICAL PROPERTIES

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Abstract

Based on traction tests, the authors assessed the influence of the PTFE concentration on the mechanical characteristics of blends PBT + PBT. The studied range of PTFE addition was 0...20% wt.

For these samples, the traction limit of PBT is 40.58 MPa, but for the blend PBT+10% PTFE, this characteristic increase to 46 MPa. For 15% PTFE in PBT, the traction limit was 45.59 MPa and for the blend with 20% PTFE, the average value was 42.37 MPa. The tendency of changing the traction limit is similar to that for the elastic modulus.

Adding PTFE in PBT is not beneficial for improving the mechanical characteristics, at least for the tested range of concentrations, but they have to known for designing tribological applications.

Key words: PBT + PTFE blend, tensile test, mechanical properties

1. INTRODUCTION

Studying the maps of the material characteristics presented by Ashby [2], one may notice that polymeric materials, including elastomers have a large area, especially for mechanical properties, but for low values, especially for mechanical properties. The blends of two or more polymeric materials could enlarge the range of some properties the design engineer is interested in [19].

Now, the progress in producing polymer parts allows for obtaining and using polymer blends that several decades were impossible [18], [14], [16]. Progress has been reported for composites with polymeric matrix [15] [9], [10].

Polymeric blends were designed and manufactured for getting a certain set of properties. Major applications include tribological applications [5], [11], bumpers, increased durability or fire resistance with acceptable ratio cost/performance.

PBT is now used for machine component due to its set of properties and not for an exceptional one [17]. In 1999, Brydson [8] din not mention PBT as a polymer for mechanical applications. The progress in manufacturing precise elements implied the robust mold machine with higher rate of molding and higher temperature [3]. Also, many additives were introduced in a PBT matrix to improve particular characteristics as the tribological ones [1], [6], [13].

PTFE is more rarely used as a neat polymer for manufacturing parts, but it is added for improving tribological characteristics [12], [4].

The blends and composites based on PBT was also studied by Georgescu [13] (adding glass beads and PTFE, respectively, but also introducing a composite PBT + glass beads+PTFE), Botan (adding 10% aramid fibers) [6].

2. Materials and testing method

The uniaxial traction tests were done on the universal machine INSTRON 8800 Minitower [25], M21-16425-RO, taking into account SR EN ISO 527-2:2012 [23], [24] and the dedicated software Console, in the Laboratory for Testing mechanical, Optical and Thermal Properties for Polymers ("Dunărea de Jos" University of Galati). The test strain rate was 5 mm/min. For each material there were tested at least 7 sample, their geometry being given in Fig. 1. The extreme values were not used in the calculation of the average values of the mechanical characteristics.

PBT grade Crastin 6130 NC010® [20], [21], [22] (as supplied in grains by DuPont. The grains of PBT were dried till the residual humidity content of 0.04 % (wt). The drying process was done in a drying oven for 2 hours, at a temperature of ~120ºC. After the sample molding (after 24 hours), they were heat treated, being maintained for 2 hours at a temperature of 175-180ºC.

The PTFE was commercial grade Flontech NFF FT-1-1T with average particle size of 20.0 μm [26].

Molding process took into account the producer recommendations [20], [21]. Bone samples were obtained by extruding the mixtures of granulated PBT and of PTFE powder, at ICEFS Savinesti, Romania.

The tested materials were PBT and blends of PBT + PTFE with the following massic concentrations of PTFE: 10% PTFE, 15% PTFE and 20% PTFE.

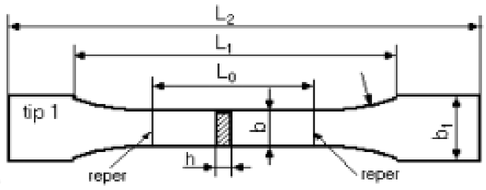


Fig. 1. The sample use for the traction test (type 1A, SR EN 527-2:2012)

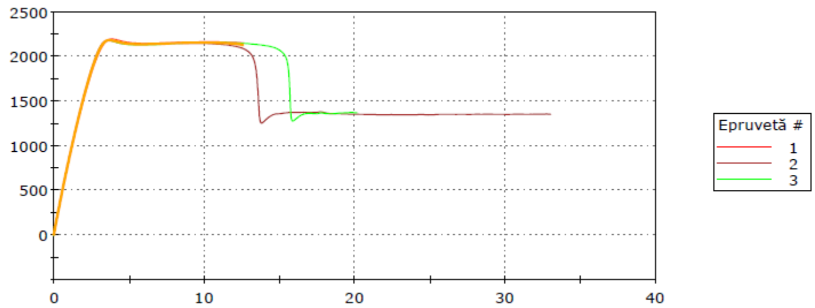
3. Results

Figure 2 presents samples after being tested in order to pint out the break nature of the tested materials (ductile for PBT and brittle for the blends)

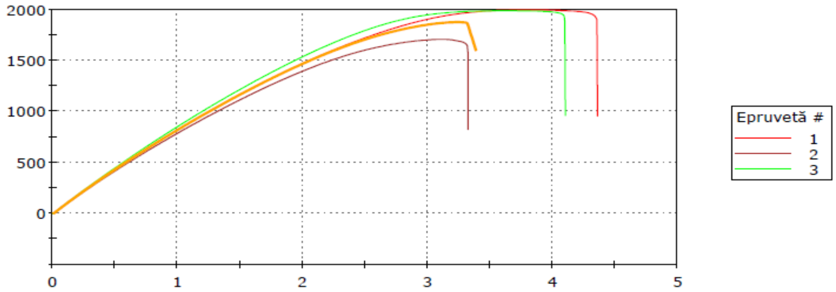
a) b) c)

Fig. 2. Several tested samples (down - sample before testing)

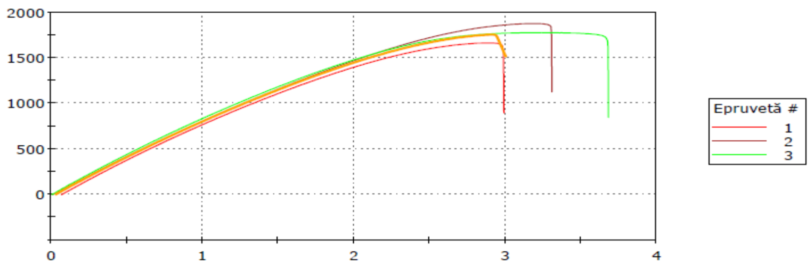
Figure 3 presents the records for several samples (selective). The test for samples made of PBT were done till 100% of the strain as the authors were interested to use these materials in applications that do not accept very high values for this parameter.



a) Sample made of PBT



b) samples made of PBT + 15% PTFE



c) Samples made of PBT + 20% PTFE

Fig. 2. *Results of the tensile tests (curves strain (%) - traction force (N), strain rate 5 mm/min*

4. CONCLUSIONS

PBT has a non-linear behavior in traction, with the yield limit higher than the strength limit [7], but the blends PBT + PTFE have a slightly non-linear behavior.

Based on traction tests, the authors assessed the influence of the PTFE concentration on the mechanical characteristics of blends PBT + PBT. The studied range of PTFE addition was 0...20% wt.

The Young modulus was greater for the blend PBT+10% PTFE that is a value of 1499.27 MPa, representing an increase with 25.47% as comparing to neat PBT (that is a value of 1881.2 MPa). For the other blends (with 15% PTFE and 20% PTFE, respectively), this characteristic is close to that of the polymer.

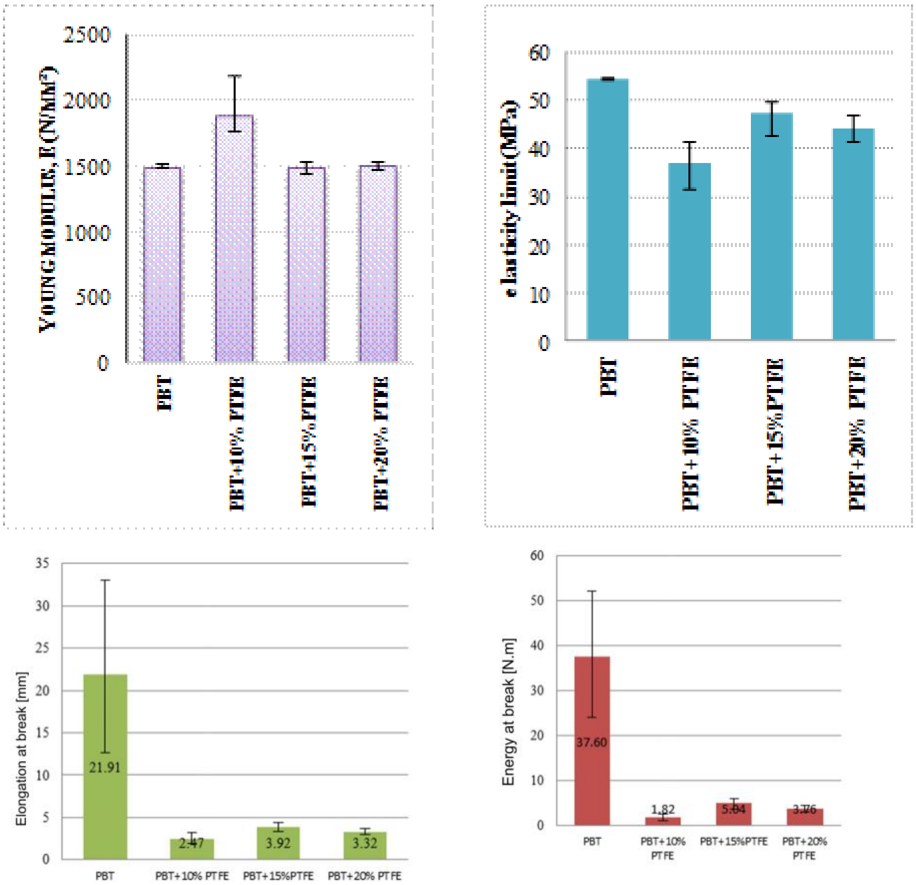


Fig. 4. Average values and spread ranges for mechanical properties (test rate 5 mm/min)

Adding PTFE in PBT makes the elasticity limit to decrease, from 54 MPa for the polymer, to 36.97 MPa for 10% PTFE, to 47.2 MPa for 15% PTFE and to 44.10 MPa for 20% PTFE.

Even if PTFE is characterized by a high elongation at break [Mark, 2007], when it is added into PBT, the blends have this characteristic of significant lower value. Even PBT has a higher value (22 mm), but the blends have only 2.47 mm for 10% PTFE, 3.92 mm for 15% PTFE and 3.32 mm for 20% PTFE, the tendency pointing out a slight increase of this characteristic with the PTFE concentration.

Even if PTFE is a linear polymer with high elasticity, when it is introduced in PBT, it produces a drastic decrease of the energy at break. Thus, this characteristic is 37.60 J for PBT, but the samples made of blends PBT + PTF have 1.82 J for 10% PTFE, 5.04 J for15% PTFE and 3.76 J for 20% PTFE.

Specialist reported that the traction limit for PTFE (20-30 MPa) is lower than of PBT, but when adding low concentration of PTFE (in this study - 10% wt), the traction limit has a slight increase. For these samples, the traction limit of PBT is 40.58 MPa, but for the blend PBT+10% PTFE, this characteristic increase to 46 MPa, meaning with 14.7% higher as compared to neat PBT. For 15% PTFE in PBT, the traction limit was 45.59 MPa and for the blend with 20% PTFE, the average value was 42.37 MPa. The tendency of changing the traction limit is similar to that for the elastic modulus.

Adding PTFE in PBT is not beneficial for improving the mechanical characteristics, at least for the tested range of concentrations, but taking into account the results obtained by [11], [13], the results on friction and wear are promising.

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