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An Investigation on the impact modifiers influence on the mechanical properties of PET/PA66/short glass fiber reinforced composites

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Abstract

The mechanical behavior of PET/PA66 blends and corresponding glass fiber reinforced composites has been investigated in the presence of the two different impact modifiers. PET/PA66 blends were prepared by lab scale twin screw extruder and PET/PA66/GF composites were prepared by another twin screw extruder equipped with glass fiber feeder. The results of PET/PA66 blends has shown that the samples strength at break was roughly equal to this parameter value in virgin PA66 but there was a significant decrease in elongation at break and specially in notched Izod impact strength. The use of the two impact modifiers has made no difference in these two properties which can be related to the lack of the convenient functional groups on the impact modifier backbones. PET/PA66/GF composites test results revealed that the impact modifiers has no positive influence on mechanical properties; however, they show efficiency in PA66/GF compounds. As strength at break of PET/PA66/GF composites is roughly equal to the PA66/GF, it would be proper to be used in different applications which is leaning on strength properties of polyamide 66.

Introduction

Nowadays the increasing demand to polymeric products, has accompanied the compounding knowledge growth. The homo-polymer compatibility in blends (i.e., the properties of the inter-phase layer) is of prime importance for their final properties. The chemical nature, molecular weight, composition and crystallizability, as well as processing conditions are other factors determining the final behavior of the blends.[1]

PET and PA are semi-crystalline polymers. Their degree of crystallinity can be controlled to a certain extent by processing conditions: viz., thermo-mechanical history, including cooling rate and annealing. Crystallinity has a great influence on the ultimate solid-state properties such as density, optical clarity, tensile and impact strength, etc.[2]

The PET/PA66/SGF composites showed good mechanical performance in flexural, tensile and impact tests demonstrating that the addition of SGFs to PET/PA66 blends is an interesting approach to obtaining new thermoplastic composites. In addition, this represents a potential application for post-consumer PET, an abundant and cheap material, in the well-established market of PA66/SGF composites, which are widely used in technical parts requiring high mechanical and thermal properties.[3]

Experimental

The supplied materials in detail are as followed: (i) PET TG645 supplied by Persian Golf Petro Chemical Co. (ii) recycled PA66 (iii) virgin PA66 (ix) short glass fiber-E (x) Random Terpolymer of Ethylene, Acrylic Ester and Maleic Anhydride Polymerized –here is named *ADD1* (xi) Polypropylene functionalized by maleic anhydride–here is named *ADD2 (*All polymeric material has been dried for 1 hour in 100 ˚C.)

The samples are divided in two groups, PET/PA66 blends and PET/PA66/GF composites.

The first group formulations are mentioned in table1. At the first phase, blends of PET/PA66 has produced by lab twin screw extruder. In all samples PET/PA66 ratio was 20/80. Temperature set was same in all steps 260 to 275 ˚C. Sample 1-0 is produced as reference.

Experimental

At the second phase, all components except glass fiber feed from main hopper. Glass fiber is fed from fiber feeder. The temperature set is same, 260-275 ˚C. Sample 2-0 is produced as reference, which consists of virgin PA66, 30% glass fiber and ADD1 impact modifier.

The first sample in second phase (sample 2-1) was based on recycle PA66 but as there was such a big difference between it's properties and the reference (sample 2-0), the base polymer changed to virgin PA66 (sample 2-2). But as it's properties doesn't seem satisfying, sample 2-3 with decrease in PET Percentage, sample 2-4 with change in additive and finally sample 2-5 without any additives were produced. Detailed formulations are available in Table 2.

Result & Discussion

The test results of both phases are depicted in table 3 and table 4. These results are considered as a their interphase behavior. Sample 1-1, in comparison with reference sample (sample 1-0), shows a significant decline in mechanical and Izod impact resistance. Compounding ADD1 and ADD2 in samples are not efficient enough to gain better properties (samples 1-2 and sample 1-3).

Glass fiber use in second phase, has made a much complicated morphology in microscopic scale which makes a much harder property forecasting in macroscopic scale. As in some of the samples the results was different from common predictions. Finally mechanical properties of both samples 2-4 and 2-5 were in the acceptance criteria range.

Conclusion

Success in attaining the target properties of these materials is dependent on several morphological aspects including the polymer blend morphology, the glass fiber size and distribution within the polymer blend and the adhesion between the glass fiber and the polymeric matrix [4].

The study on mechanical properties and Izod notched impact resistance of sample 2-5 shows that the use of polyethylene terephthalate up to 20% of polyamide66 would be roughly acceptable. The investigations in both phases shows that the consumed impact modifiers weren't efficient enough to improve mechanical properties of composites.

References

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Table & Figures

Material \ Sample	Sample 1-0	Sample 1-1	Sample 1-2	Sample 1-3
PET	0	22	20	20
Recycled PA66	98	76	70	70
ADD 1	0	0	8	0
ADD 2	0	0	0	8
Master batch (black)	2	2	2	2

Table1: First Group Samples

Material \ Sample	Sample 2-0	Sample 2-1	Sample 2-2	Sample 2-3	Sample 2-4	Sample 2-5
PET	0	12	12	7	12	12
Recycled PA66	0	0	0	0	48	0
Virgin PA66	60	0	48	53	48	56
Glass Fiber	30	30	30	30	30	30
ADD 1	8	0	0	0	8	0
ADD 2	0	8	8	8	0	0
Master batch (black)	2	2	2	2	2	2

Table 2: Second Group Samples

Sample \ Test	Stress at Break (MPa)	Elongation at Break (%)	Izod notched impact resistance (Kj/m2)
Sample 1-0	75	18	12.1
Sample 1-1	66	5.55	3.25
Sample 1-2	3.2	5.63	60
Sample 1-3	4.06	5.4	67

Table 3: Mechanical Test Results- First Phase

Sample \ Test	Stress at Break (MPa)	Elongation at Break (%)	Izod notched impact resistance (Kj/m2)
Sample 2-0	132	7	18.5
Sample 2-1	84	5.2	5.34
Sample 2-2	102.3	6.3	9.1
Sample 2-3	118	6.8	21
Sample 2-4	116	8.4	19.5
Sample 2-5	127.6	7.7	18.1

Table 4: Mechanical Test Results- second Phase