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FILLED POLYMER COMPOSITES BASED ON MODIFIED POLYPROPYLENE

Abdukarimova S. A.
PhD., Tashkent State Technical University

Yodgorov N. N.
PhD., Tashkent State Technical University

Makhkamova L. K.
Assistant, Tashkent State Technical University

Yusupova G. B.
Master Student, Tashkent State Technical University

ABSTRACT

Glass fibers (GF) are the reinforcement component most used in Polyamide (PA), polycarbonate(PC), polybutylene terephthalate (PBT) and polypropylene (PP) based composites, as they have good balance between mechanical properties and costs. Reinforced Polypropylene composites final properties are mainly determined by the strength and stability of the polymer- PP-g-MAH- glass fiber interphase. Glass fibers do not act as an effective reinforcing material when the PP-g-MAH concentration is low. The effect of process parameters on the mechanical properties of composite manufactured specimens is discussed based on the results of tensile tests, three-point flexural tests, Izod impact tests, heat distortion temperature and melt index.

Keywords: glass fiber/ PP-g-MAH/polypropylene composites; adhesion; mechanical properties.

INTRODUCTION

Glass fibers, especially, roving and chopped fibers are considered as the prevailing reinforcement in the polymer engineering composites. High strength glass fibers as well as embedded in a matrix modulus form the fiber-reinforced composites, where both constituents hold their physical and chemical properties. However, the new material carries the properties which cannot be achieved either of the content's sole performance. Basically, fibers are known as the fundamental load-carrying members, whereas the main functions of the matrix are as follows: transfer of stresses between the fibers, provision of barrier against environmental adverse effects and protection of surface of fiber from mechanical abrasion [1,2]. However, there is a crucial issue remaining in adjusting "well-bonded and durable interphases" and in their reinforcement. Specifically, this criticality manifests itself clearly in thermoplastic polymer matrices including PE, PP, and PA. As long as effectiveness of reinforcement solely relies upon the adhesion of matrix and fiber, this can be assumed as the crucial factor in determining composite materials' ultimate properties, especially, mechanical properties. This adhesion restricts to "third phase" (often called as "interphase") where there occurs stress-transfer. At the same time, interphase is considered as the tridimensional region whose location takes part between fiber and polymer matrix. Therefore, this transition region carries its own unique

characteristics corresponding to none of the fiber and matrix properties and it called as Materials [3].

EXPERIMENTAL SECTION

The selected commercial grade of Random Polypropylene (PP B520- blow grade of Uz-Kor Gas Chemical JV) and Block Polypropylene (PP J-350 injection grade of Uz-Kor Gas Chemical JV) are commonly used for extrusion and injection molding applications. A maleic anhydride-grafted polypropylene, PP-g-MA, (MEP PP-g-MAH, POLYMER PIGMENT LLC) was used as a compatibilizer. The chopped strand GFs of 13 micron in diameter and 4,5 mm length, respectively, with an adequate surface treatment intended for use in polypropylene matrices were provided by Shandong fiberglass -925ERC. Melt Processing composites were manufactured at an industrial scale using a co-rotating intermeshing twin-screw extruder (L/D 44) operating at a barrel temperature of 240˚C, a feed rate of 800 kg/h, and a screw speed of 600 rpm.

RESULTS AND DISCUSSION

Physical and mechanical properties. The results of tensile tests are reported in Table 2. Generally, for polymer composites, the percentage of elongation at break decreases with the addition of glass fiber to ductile polymer matrix, despite the state of the inter-face between different phases [4].

Table 2. Values of physical and mechanical properties or the composites.

Name	Standards	PP B-520	PP B-520	PP B-520 4% PP-g-MA	PP J-350	PP J-350	PP B-520 4% PP-g-MA
			30% GF	30% GF		30% GF	30% GF
Melt index, 2.16 kg/10 min at 230⁰C	ASTMD 1238	2	0,8	0,7	10	4,7	4,5
Density,	ASTMD 792	0,88	1,132	1,135	0,88	1,129	1,133
Ash	ASTMD 482	0	30	30	0	30	30
Tensile strain, MPa	ASTMD 638	26	68,7	91,7	25	65	81,7
Elongation at Break, %	ASTMD 638	100	6,94	9,2	100	4,5	5,3
Flexural Modulus, MPa	ASTMD 790	1200	5000	5200	1200	4700	5100
Notched Izod Impact Strength (23 ⁰C) J/m²	ASTMD 252	6	16	18	7	14	17
Notched Izod Impact Strength (-30 ⁰C), J/m²	ASTMD 252	1,5	9,7	11,6	2,5	8,4	10,5
Heat Distortion Temperature (4.6 kgf/cm²)	ASTMD 648	85	147	156	95	140	157

However, the addition of the PP-g-MAH compatibilizer mitigates the negative effect of fiber reinforcement on the tensile elongation to some degree. It improves 2 to 6 % on average (Table 2).

In addition, it is known that the initial modulus of a composite is determined primarily by the elastic properties of the material and, theoretically, (i.e., assuming per-fect wet-out) it is not affected by the level of fiber/polymer matrix adhesion. So, a high increase in modulus is expected

with the fiber addition. In our opinion, this is due to the long dimensional glass fibers, as they themselves have a modulus of elasticity at 70 GPa compression. Otherwise, the tensile strain of the PP-based composites are very similar up to the failure of PPGF30/ PP+PP-g-MAH+GF30. This indicates that the principal effect of the addition of PP compatibilizer appears to increase the stress and strain to the failure of the composite.

Based on the aforementioned experimental results, the interfacial bonding between the glass fiber and PP matrix is improved by PP-g-MAH addition. This increase may explain the important role of the compatibilizer which makes the bonds between the macromolecular chains of PP and surfaces of fibers closely related and difficult to separate. Therefore, the impact absorbing capacity is increased and the material becomes more flexible [8] and will increase density from 0.88 to 1.35 gr/cm3 of PP+GF30 and PP+PP-g-MA+GF30 (FIG. 1) .

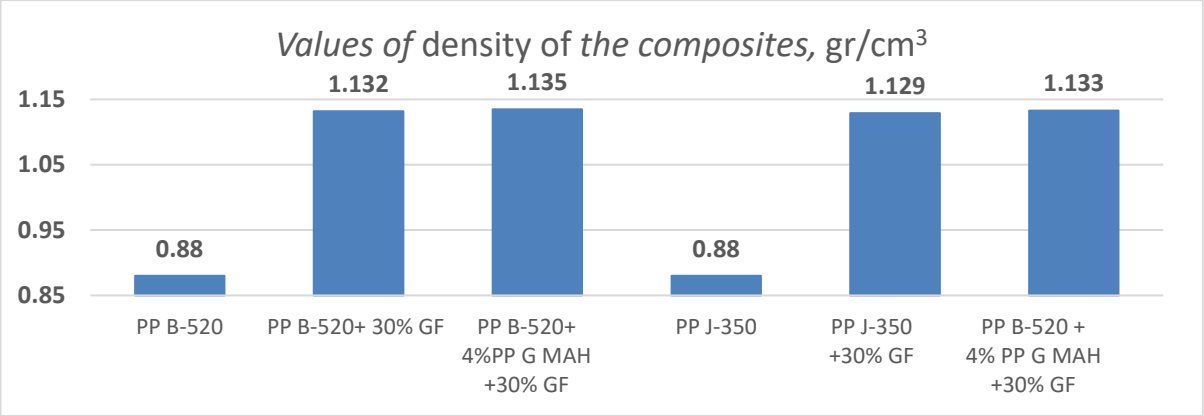

Figure 1. Values of density of the composites, gr/cm3

Thermal Properties. The DSC results of composites are presented in Table 2 which lists thermal properties of base PP J350, PP+GF30, and PP+PP-g-MAH+GF30 composites. Here, it is worth noting that although the melting temperature of all composites did not change significantly with the addition of the PP-g-MAH compatibilizer compared to PP+GF30, the degree of crystallinity values decreased. It is significantly improved Melting point of composites. Indeed, the obtained results have shown that the interfacial adhesion was substantially improved when PP-g-MAH was added.

Table 2 which lists Melting point (T_m) and degree of crystallinity (X_c) of block polypropylene (PP), PP+GF30 and PP+PP-g-MAH+GF30.

Name	T_m (°C)	X_c (%)	Melt index, 2.16 kg/10 min at 230°C
PP J350	155	54.4	10
PP+GF30	161	49.8	4.7
PP+PP-g-MAH+GF30	162	42.1	4.5

This was proved by the important improvement in flow capacity, better orientation of the fiber via higher average length values and narrower length dispersion, on the one hand, and by the enhancement of the mechanical properties, on the other hand. Indeed, significant differences in the fiber stress at the composite failure were found to be dependent on the addition of the MAPP compatibilizer to the system. Therefore, one can conclude that fiber length occupies a leading

position compared with the crystallinity. In fact, fibers affect much more the mechanical properties than matrix.

CONCLUSIONS

There was conducted an investigation on the effect of addition of maleic anhydride grafted polypropylene (PP-g-MAH) and glass fiber on the characteristics of polypropylene composite. The analysis of temperature, melt index and fiber orientation was carried out in accordance with the study of physical and mechanical properties. Accordingly, it can be noted that, adding PP-g-MA compatibilizer results in the substantial improve in interfacial adhesion. It can also be demonstrated, from one side, by improving in flow capacity as well as better fiber orientation by the means of higher average length values and narrower length dispersion, and from another side, by enhancing the mechanical properties. Indeed, it was found that significant differences in the fiber stress during the destruction of the composite depend on the addition of a MA-PP to the system. It should also be noted that, modified PP+PP-g-MA+GF30 composite shows better characteristics than PP+GF30 as a reference. Furthermore, it was confirmed that, reinforced glass fiber along with PP-g-MA compatibilizer improves random or block polypropylene. It was acknowledged that, the mechanical properties of polymers improve with the addition of glass fiber and PP-g-MAH regardless of the nature of polypropylene (random or block).

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