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Abstract

The Effect of Graphene Nanoplatelets on the Properties of Hybrid Polyamide/Glass Fiber Composites †

Andreea Afilipoaei, Zina Vuluga *, George-Mihail Teodorescu, Monica Cărăulașu, Augusta Raluca Gabor, Cristian Andi Nicolae and Mihai Cosmin Corobea *

INCDCP-ICECHIM Bucharest, 202 Spl. Independentei, 6th District, 060021 Bucharest, Romania; andreea.afilipoaei@icechim.ro (A.A.); george.teodorescu@icechim.ro (G.-M.T.); monica.caraulasu@icechim.ro (M.C.); raluca.gabor@icechim.ro (A.R.G.); cristian.nicolae@icechim.ro (C.A.N.)

* Correspondence: zvuluga@icechim.ro (Z.V.); mihai.corobea@icechim.ro (M.C.C.)

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Currently, the method of solving the issues related to the environment has become a topic of great interest and is approached by researching several directions, such as recycling or the replacement of polluting materials [1]. Most glass fiber (GF) composite wastes are non-biodegradable and very bulky, causing serious environmental problems [2]. Given the requirements of the European Commission to reduce CO_2 emissions by at least 40%, it is possible to consider reducing the weight of automotive by replacing metal parts with high-performance polymer composites with a low impact on the environment [3]. Starting from the development of a new nanocomposite material based on bio-polyamide and 2D nanostructure that has improved properties [4,5] and can be used to obtain automotive parts, the possibility of reducing the content of glass fiber with graphene nanoplatelets in composite based on PA6 and 30% GF was studied.

A full bio-based polyamide 1010 (PA1010), a polyamide 6 (PA6), a composite with PA6 and 30% glass fiber (PA6GF30) and graphene nanoplatelets (M5) with a particle diameter of 5 μm and an average thickness of approximately 6–8 nm were used in this study. Hybrid composites based on PA, GF and M5 were obtained by using the masterbatch method. M5 masterbatches at 39 wt.% were obtained based on both PA1010 (MB1010) and PA6 (MB6), which were diluted with PA6GF30 to the desired M5 concentration. Both masterbatches and hybrid composites were obtained under dynamic conditions using a double screw extruder. The resulting hybrid composites were characterized in terms of thermal properties (TGA and DSC), mechanical properties (tensile and impact test) and dynamic-mechanical analysis (DMA).

The dilution of the MB1010 masterbatch with PA6GF30 composite resulted in hybrid composites with a mixture of PA1010 and PA6 as a polymer matrix, which at 5 wt.% M5 showed an interesting property profile. In comparison with the starting PA6GF30 material, the strength and stiffness of the hybrid composite was affected by approximately 29% and 25%, respectively. Moreover, impact strength decreased with approximately 18%. By contrast, a smaller decrease was attained for the strength and stiffness by approximately 12%, respectively, and 8% while maintaining the impact strength when the masterbatch MB6 was diluted with PA6GF30 composite.

It is possible to reduce at least 16 wt.% of the GF (from the overall 100 wt.% GF found in neat PA6GF30) with M5, with good compromise in comparison with the starting PA6GF30 and still meet automotive field material properties requirements. By the dilution of PA6-based masterbatch with PA630GF composite, hybrid composites with better properties were obtained.

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