MANUFACTURING AND CHARACTERIZATION OF NANOCOMPOSITES BASED ON PLA GRAPHENE NANOPLATELETS FOR 3D PRINTING APPLICATION

João Antonio Nery da Silva[1]*; Jorge Tadao Matsushima[1,3], Beatriz Carvalho da Silva Fonseca[3], Maurício Ribeiro Baldan[3], Rafael T.L. Ferreira[2], Rita de Cássia Mendonça Sales Contini[1,2]

[1]Faculdade de Tecnologia de São José dos Campos, [2]Department of Aeronautics, Laboratory of New Concepts in Aeronautics, Aeronautics Institute of Technology, [3]Instituto Nacional de Pesquisas Espaciais, INPE

*joaonerysilva@outlook.com

Abstract

The main objective of this work is the nanocomposite manufacture from graphene nanoplatelets and PLA for application in additive manufacturing. To characterize this new material's mechanical and thermal properties, the DSC, DMA, and FEG-SEM techniques were used. the results showed that the filler/matrix interaction of the mechanical mixture resulted in a good interface in comparison with the solvent mixture. However, a slight decrease in melting temperature was observed and an increase in both crystallinity degree and glass temperature.

Introduction

The polymeric filament based on PLA (Polylactic Acid) is the most used in the Additive Manufacturing process called FFF (Fused Filament Fabrication) [1], which consists of heating, extrusion and layering of the material in order to obtain a desired geometry. To improve the properties of this material, it is possible to add reinforcing fillers such as Graphene Nanoplatelets (GNP), which consist of stacking 10 to 100 sheets of Graphene [2], a two-dimensional (2D) material composed of honeycomb-shaped carbon atoms. The main objective of this work is the fabrication and characterization of the physical-mechanical properties of filaments for 3D printers produced with the incorporation of 10% w/w GNP in the PLA matrix.

Materials and Methods

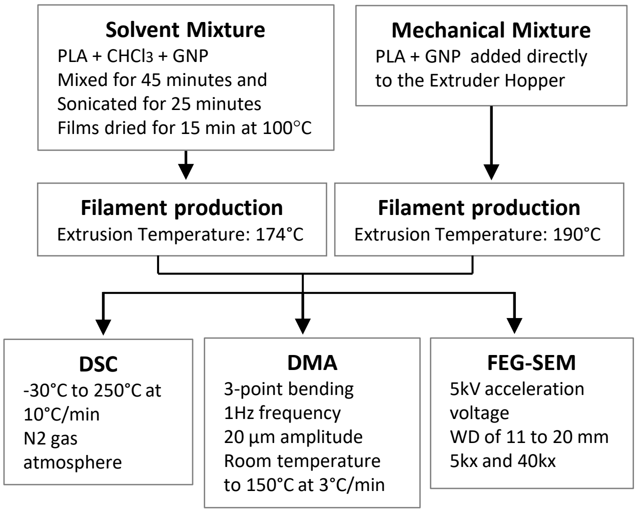

Fig. 1 – Materials and Methods Workflow

Results and Discussions

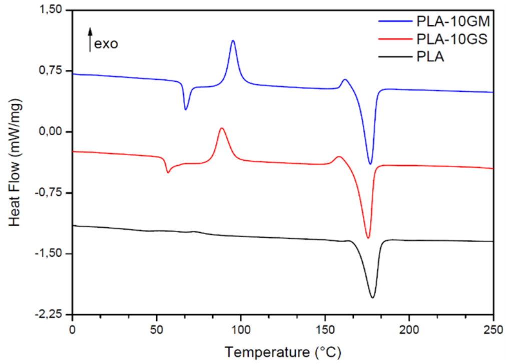

Fig. 2 – Thermogram for PLA, PLA-10GS and PLA-10GM

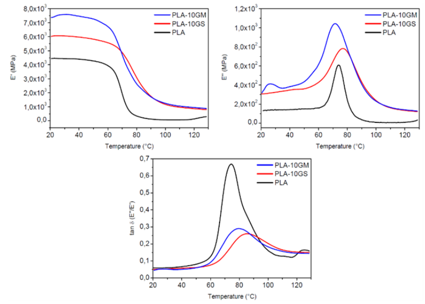

Fig. 3 – Dynamic-Mechanical Properties: a) E', b) E" and c) tan δ

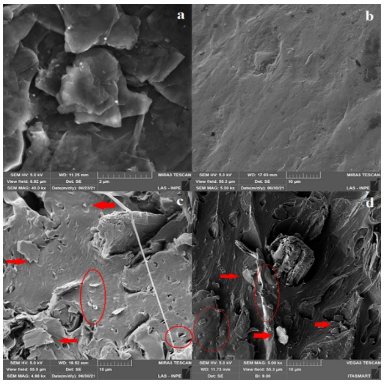

Fig. 4 – FEG-SEM Images of a) Graphene Nanoplatelets, b) PLA, c) PLA-10GM and d) PLA-10GS

Conclusion

It was showed that the nanofiller contributed to the increase in the PLA polymer stiffness, in addition to an increase in glass transition temperatures and a drop in melting temperature. It was also observed that the filler/matrix interface had a good interaction in the PLA-10GM sample. More studies are needed to obtain a better filler/matrix dispersion while maintaining good interaction, an essential factor when dealing with composite materials.

Acknowledgements

This project was partially supported by CNPq (PIBITI) process n°143534/2020-3. The authors also thank the FATEC (SJC) and CPS, LNCA at the Aeronautics Institute of Technology (ITA), COPDT, and CGIP at the National Institute for Space Research (INPE) for the infrastructure offered for the development of this project.

Referências

[1] Ngo, T. D., Kashani, A., Imbalzano, G., Nguyen, K. T. Q., & Hui, D., *"Additive manufacturing (3D printing): A review of materials, methods, applications and challenges." Compos. B. Eng., vol. 143, pp. 172–196, Jun. 2018,* doi:10.1016/j.compositesb.2018.02

[2] Dul, S., Fambri, L., & Pegoretti, A., *"Development of new nanocomposites for 3D printing applications." in Structure and Properties of Additive Manufactured Polymer Components, 2020, pp. 17–59.*