Influence of GNS on mechanical properties and morphological characteristics in nanocomposites of PFA/GNS

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INTRODUCTION

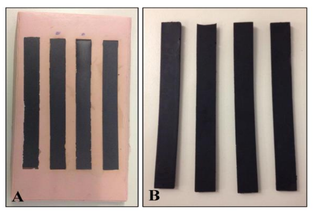
The multifunctional green nanostructured composites are aimed at the development of new technologies that allow the use of lower environmental impact products, from renewable sources and environmentally friendly with similar or better physical/mechanical properties when compared with actual applied materials [1]. Currently, it appears that agribusiness generates numerous sources of biomass, which are often rejected by the industrial sector. However, these could be better used and transformed into raw material to other products. In this sense, there is, for example, bagasse from sugarcane, which is a byproduct of the agriculture industry, already being used in the production of furfuryl bioresin. In this context, this work aims to obtain green nanocomposites to add benefits in manufacturing and application artifacts that make up the interior of aircraft, with the advantage of being derived from renewable sources, with lower production costs, as well as being environmentally friendly [2].

The present research had as main purpose to develop and characterize multifunctional green nanocomposites based on poly(furfuryl alcohol) resin (PFA), derived from sugarcane bagasse reinforced with different contents of graphite nanosheets (GNS) (0.5, 1.0, 1.5 and 2.0 wt%) which were dispersed in PFA bioresin using an ultrasonic processor. The morphology of neat PFA and PFA/GNS nanocomposites was analyzed by Field Emission Gun-scanning Electron Microscopy (FEG-SEM) and the mechanical properties by Izod impact strength.

EXPERIMENTAL

PFA/GNS nanocomposites (0.0, 0.5, 1.0, 1.5 and 2.0 wt%) were sonicated for 4 min in ultrasonic processor.

Then the PFA samples were catalyzed with 2.5 w/w% of diluted *p*-toluenesulfonic acid (60 w/v%) and were cast in silicone molds.



Afterwards, they remained at room temperature for 24 h, and then were placed inside an oven, according to the following thermal cycle: 60 ºC, 80 ºC, 100 ºC, 120 ºC, 140 ºC, 160 ºC and 180ºC for 1 h in each temperature.

RESULTS AND DISCUSSION

❖ Izod Impact Strength

✓ The presence of higher concentrations of GNS in the PFA bioresin did not result in the formation of stress concentration regions that could act as failure points in the matrix, what could result in a reduction of impact resistance.

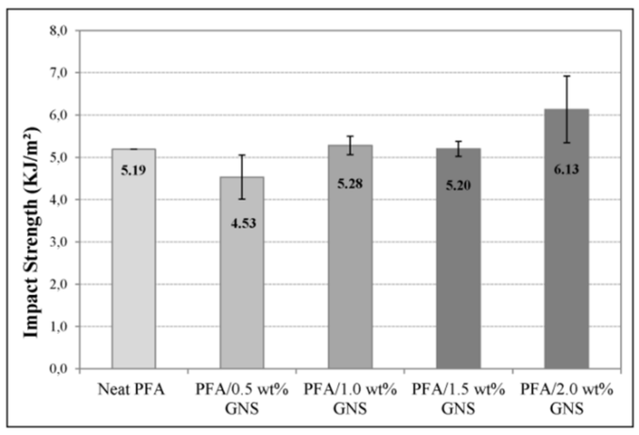


Fig. 1: Values of the Izod impact strength of neat PFA and PFA/GNS nanocomposites.

✓ PFA/0.5 wt% GNS showed 13% decrease in the impact resistance values, even though it presented good interfacial adhesion between GNS and PFA bioresin.

✓ The other nanocomposites (PFA/1.0 wt% and PFA/1.5 wt%) presented a slight increase in the impact resistance, and specially PFA/2.0 wt%, showed a maximum improvement of 18% (compared to neat PFA bioresin) in impact strength values.

✓ This fact may be related to an increased dispersion of GNS content in the PFA bioresin that dissipated the fracture energy and consequently increased the impact resistance.

❖ FEG-SEM

The fracture surface of neat PFA was smooth (typical of fragile fracture), whereas for the nanocomposites the surface became rougher, proportionately to the GNS concentrations increase. Moreover, it was observed that GNS in all concentrations were well dispersed in PFA bioresin and it was possible to observe a good interaction between GNS and the matrix.

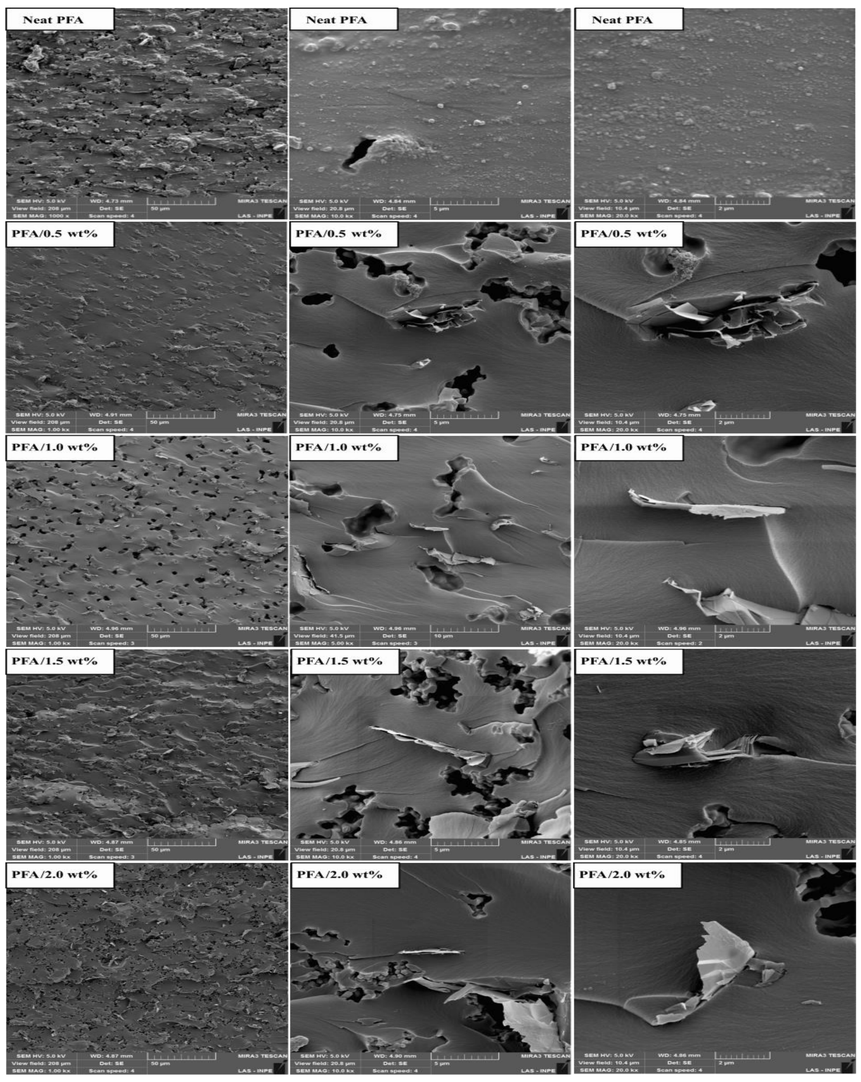


Fig. 2: FEG-SEM cryogenically fractured micrographs of neat PFA and PFA/GNS nanocomposites with different contents of GNS (0.5, 1.0, 1.5 and 2.0 wt%) in three different magnifications (1000x, 5000x and 20000x).

CONCLUSIONS

✓ This research showed that it is possible to develop multifunctional materials, using raw materials from renewable sources, in order to reduce the environmental impact and even production costs. In this way, nanocomposites based on poly(furfuryl alcohol) bioresin and GNS were successfully prepared.

✓ The best results of impact resistance were observed for the sample PFA/2.0 wt% GNS, showing that higher GNS content improved on the final properties of the samples.

✓ The increased impact resistance (up to 18% compared to neat PFA bioresin) can be correlated to the good distribution and interfacial adhesion of GNS in the PFA matrix, as shown by FEG-SEM micrographs.

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