

Supplementary Information

Hybrid Structures Made of Polyurethane/Graphene Nanocomposite Foams Embedded within Aluminum Open-Cell Foam

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FTIR

Figure S1 shows the normalized FTIR spectra of the polyol, MDI, PUF and PUF nanocomposites prepared with 2.5 wt.% of GNPs (PUF/GNPs2.5) and with 2.5 wt.% of GO (PUF/GO2.5). The MDI spectrum shows a sharp and strong peak at 2250 cm⁻¹ assigned to isocyanate groups that disappears after the foam formation, suggesting its complete consumption through the reaction with the hydroxyl groups from the polyol (the band located between 3150 and 3600 cm⁻¹). The pristine PUF and PUF nanocomposite spectra show bands at 3150 and 3600 cm⁻¹ from N–H stretching, a strong and sharp peak located at 1710 cm⁻¹ due to the stretching vibrations of the C=O and the bands between 1540 and 1517 cm⁻¹, attributed respectively to C–H and N–H of the urethane groups, confirming the formation of urethane and urea groups [1]. In the spectra of the PUF nanocomposite, the band located between 3200–3600 cm⁻¹ region is narrower, with high intensity at 3250 cm⁻¹. This could be explained by possible interactions between fillers and MDI, as reported by Gama et al [2]. The 1595 cm⁻¹ absorption peak is caused by the vibration of C=C in benzene ring from graphene and MDI structure and the strong peak around 1100 cm⁻¹ from the ether bond C–O–C stretch. It is worthwhile to note the difficulty related with the identification of the GBMs in the PUF nanocomposites, not only due to the overlap of the bands of these fillers and the polymer, but also due to its low content when compared with the polymeric matrix [1–3].

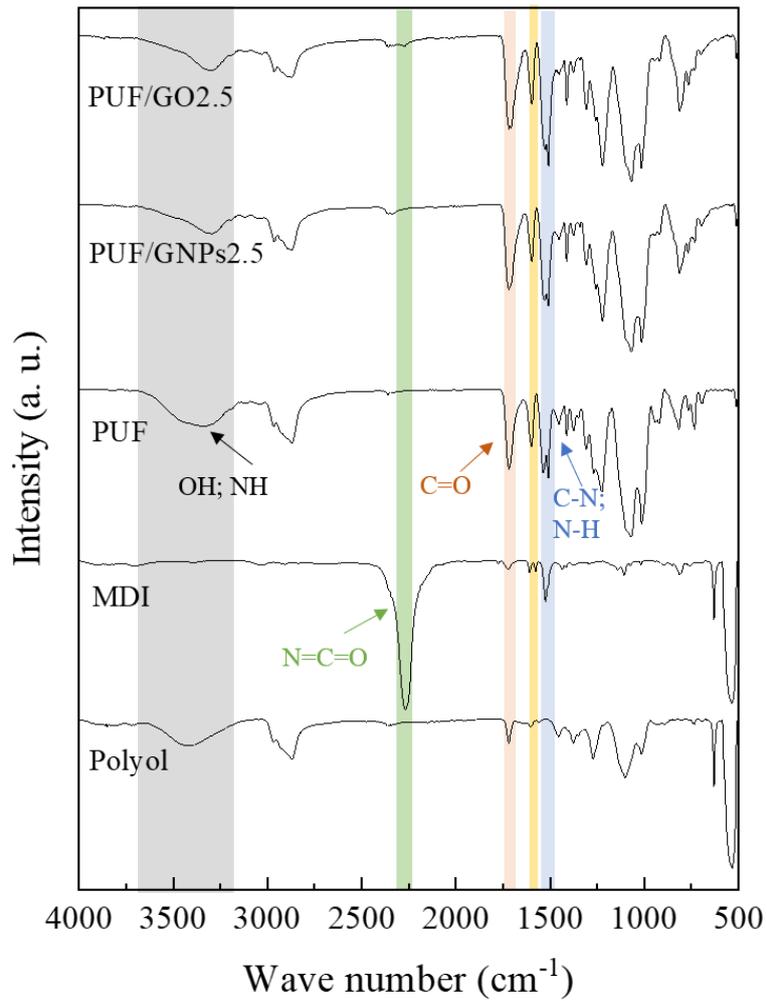


Figure S1. Normalized FTIR spectra of MDI, Polyol, PUF, PUF/GNPs2.5 and PUF/GO2.5.

FLAME TEST

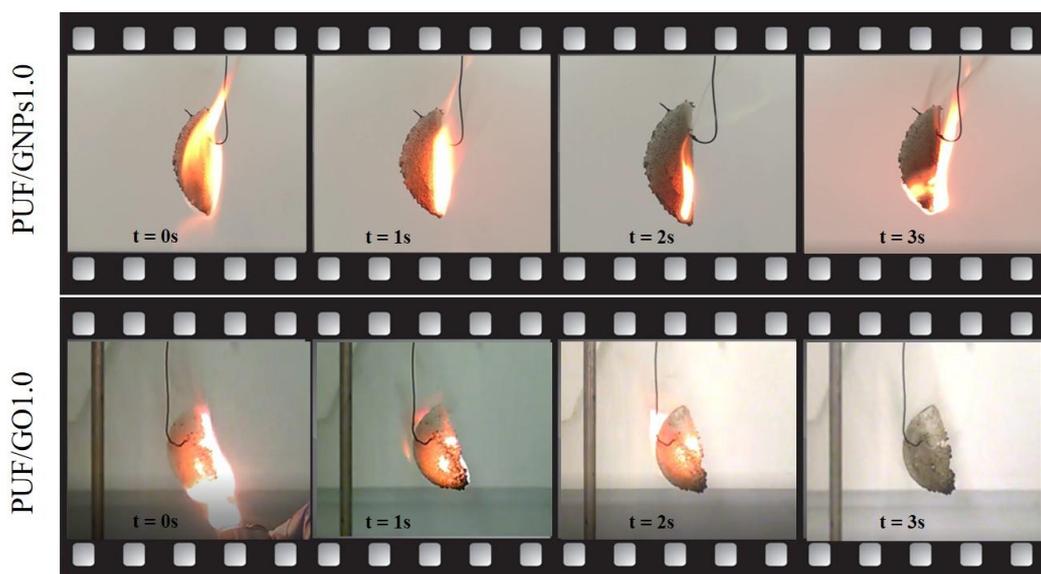


Figure S2. Flame response of PUF/GNPs1.0 and PUF/GO1.0.

THERMOGRAVIMETRY

The difference in the thermal stability of GBM-filled foams opposed to unfilled PUF was in the weight-loss percentage associated to each step. A slight weight loss before 160 °C was verified for all the specimens corresponding to adsorbed water evaporation. The second stage of weight loss (around 25%), in the temperature range between 250 to 380 °C, is mainly attributed to the break of urethane bonds and precursors, such as polyols and isocyanates release. From 500 °C to 620 °C, there is one-third weight loss from the oxidative decomposition of isocyanate and aromatic compound and CO₂, HCN or NO₂ formation [4–7].

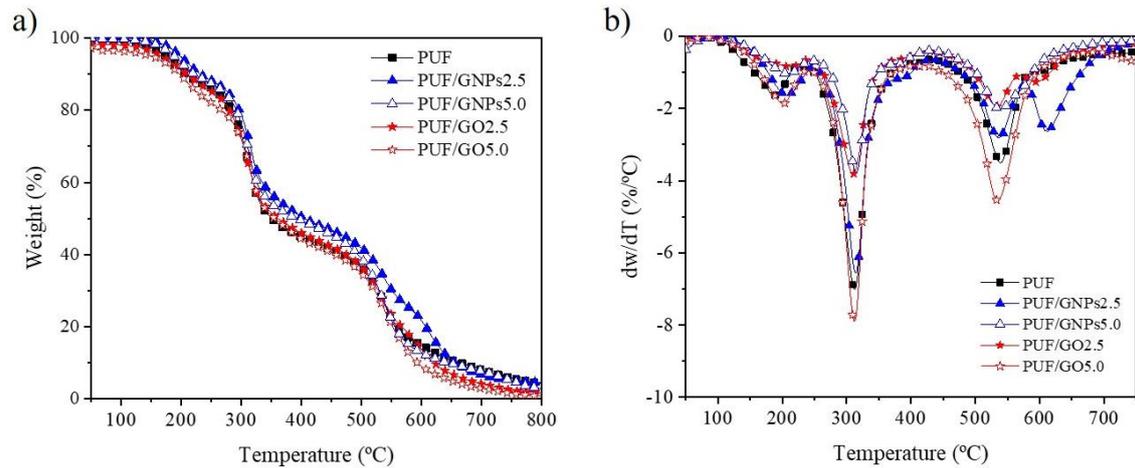


Figure S3. (a) Thermogravimetric (TG) and (b) derivative thermogravimetric (DTG) curves of PUF with different graphene based materials (GNPs and GO) additives under oxidative atmosphere.

EAD and SEA

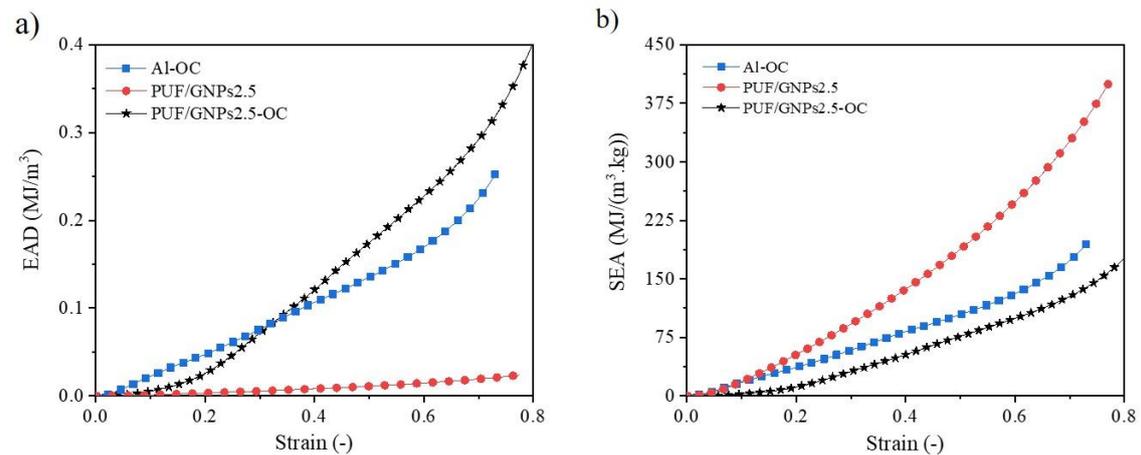


Figure S4. (a) EAD and (b) SEA curves of Al-OC; PUF/GNPs2.5 and PUF/GNPs2.5-OC.

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