Enhancement of Gas Barrier and Mechanical Properties in Polymer Nanocomposites using 2D Materials

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Together with their exceptional electrical, thermal and mechanical properties, graphene is also being explored for gas barrier applications in packaging, chemical processing and transportation industries. Its impermeable structure and high aspect ratio create a tortuous path for gas molecules within the polymer matrix[1], thus making it difficult for gas to diffuse and get transported across the membranes. In this study, we investigate the effect of different aspect ratios of graphene on the gas barrier properties of the polymer nanocomposites (PNCs), where the nanofillers have been incorporated. Poly methyl methacrylate (PMMA) PNCs were prepared by solvent casting technique, using different types of graphene powders dispersed into acetone and chloroform, with the help of sonication. The as prepared PNCs demonstrated significant improvements in the gas barrier properties of the polymer matrix, depending on their aspect ratios, and in particular, a reduction of 72 % in the gas permeability was observed when graphene flakes with the highest aspect ratio was used. The oxygen transfer rate (OTR) was reduced from 232 mL/m^2.day for the pristine PMMA films, to 65 mL/m^2.day at 3.0 wt.% graphene mass loading. This can be attributed to the good dispersion of the graphene flakes into chloroform solvent[2] and packing of the graphene flakes into PNCs. Likewise, mechanical properties (Young's modulus) of the as prepared PNCs were improved at similar mass fractions, making the PNCs more resistant to deformations. The prepared nanocomposites have been also characterized using SEM, TEM and Raman spectroscopy.

References

[1] Yoo B. M., Shin H. J., Yoon H. W., Park H. B., Journal of Applied Polymer Science, 131 (2014) 39628

[2] Johnson D. J., Dobson B. P., Coleman K. S., Current Opinion in Colloid and Interface Science, 5 (2015) 367

Figure

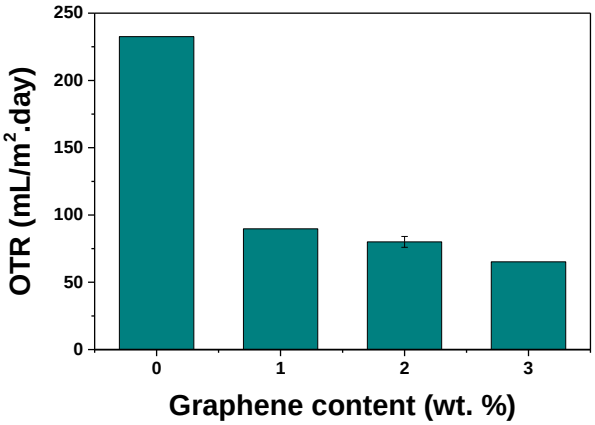

Figure 1: Effect of graphene mass contents on gas barrier properties (oxygen transfer rate) of the PMMA nanocomposites. Here 0 wt. % indicates a pristine PMMA film.