# Graphene Nanoplatelets: Ideal Fillers to Enhance Barrier, Mechanical and Thermal Properties in Thermoplastic Polymers

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Graphene nanoplatelets (GnPs) with more than eight carbon layers have emerged as excellent materials for many applications due to their unique structure, material properties, and production costs[1]. For instance, polymer composites filled with graphene nanoplatelets demonstrate enhanced electrical, mechanical and thermal properties[2][3]. Recently, it has been established that GnPs also display superior gas barrier properties as compared to single-layer or bilayer graphene when incorporated to the polymer films[4]. For this reason, multilayer graphene structures have been studied to improve gas barrier properties in thermoplastic polyurethane (TPU) films. The TPU and GnPs films were prepared by solution blending using chloroform as a common solvent with the help of sonication. After complete evaporation of the chloroform medium, the as-prepared films were characterized for their gas barrier, mechanical and thermal properties. The GnPs nanostructures form a highly tortuous inside the polymer matrix and make it difficult for gas molecules to diffuse through it[5]. Therefore, the TPU films incorporated with GnPs displayed a high degree of gas barrier properties. As such, $O_2$ gas permeability of the as-prepared films was reduced by 60% and 64% at GnPs concentration of 1 wt.% and 2 wt.%, respectively, as compared to neat TPU films. At a high concentration level, such as 4 wt.%, the reduction in $O_2$ gas permeability reached 73%. However, further inclusion of the GnPs (5 wt.%) could not produce any significant difference. On the other hand, when TPU/GnPs films with 4 wt.% concentration were mechanically hot pressed at 5 metric tonnes force and 150 °C for 30 minutes, the total reduction in $O_2$ gas permeability reached to 81%. It can be attributed to the rearrangement and alignment of the GnPs inside the polymer matrix. Moreover, the prepared TPU/GnPs films demonstrated superior mechanical and thermal properties as compared to the neat TPU films. As such Young's Modulus was reached from 5.6 MPa to 30 MPa and thermal conductivity from 0.027 W/m K to 0.82 W/m K at 4 wt.% mass loading of the GnPs. In addition to this, the prepared composite films were also studied for their morphological, structural and chemical analysis.

References

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Figure

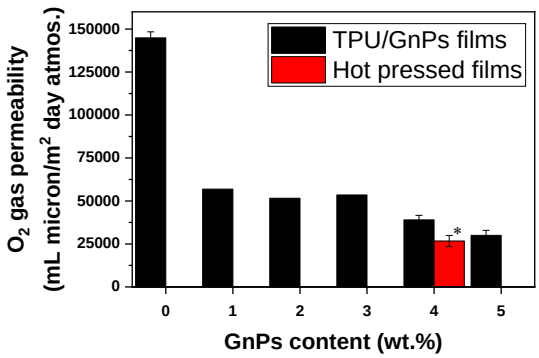


**Figure 1:** Gas barrier properties of the TPU/GnPs composite films. *Sample is hot pressed at 5 metric tonne force and 150 °C for 30 min prior to measurement.

"This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 785219 – GrapheneCore2".