# Graphene as Reinforcement Filler in PMMA Nanocomposites

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Graphene/polymer nanocomposites have been the focus of many investigations due to their exceptional thermal, mechanical and electrical properties. The exfoliation of graphite is the most promising route for producing graphene on the bulk scale for applications such as composites. Recently graphene oxide (GO) prepared using the Hummers' method [1] has been shown to be composed of functionalized graphene sheets decorated by strongly-bound oxidative debris acting as a surfactant that stabilizes aqueous GO suspensions [2]. These physi-absorbed aromatic acids can be removed by a simple $NaOH_{(aq)}$ wash to give base-washed GO (bwGO) reducing the oxygen content from 33% to < 20%, turning the hydrophilic nature of GO into hydrophobic, and improving the conductivity of films made from the material by 5 orders of magnitude [2].

The presence of these physi-absorbed groups on GO could potentially lower the Young's modulus of the flakes, as it turns the flake into a few-layer material, providing an easy shear plane between the debris, attached to the polymer. At the same time, such debris may improve the interface between the GO and matrix by acting as a compatibilising surfactant between polymer and filler. And they also may improve the dispersion of the graphene oxide in the polymer matrix, and hence the mechanical properties.

Herein, we compare as-made and base-washed graphene oxide materials as reinforcing fillers in PMMA to establish the relative roles of the interface and GO modulus, and determine whether it is better to use as-made GO or base-washed, clean GO in nanocomposites. The nanocomposites were prepared at loadings from 0.5 to 10 wt.% by melt mixing using a twin-screw extruder. Gel permeation chromatography (GPC) and thermogravimetric analysis (TGA) were used to determine the structural properties of the matrix of the neat polymer and nanocomposites. Electrical measurements, dynamic mechanical thermal analysis (DMTA) and tensile testing were performed to study the electrical and mechanical properties of the nanocomposites, respectively, as a function of their structure, surface chemistry and dispersion in the polymer matrix. The nature of the interactions at the GO/bwGO-polymer interfaces were evaluated by Raman spectroscopy and related to the mechanical reinforcement of the nanocomposites observed upon the addition of the different types of GO.

## References

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