Materials Science & Engineering C-Materials for Biological Applications. Volume:77. Pages: 1003-1011. August 2017

# Graphene oxide versus graphene for optimisation of PMMA bone cement for orthopaedic applications

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**Abstract— Graphene (G) and graphene oxide (GO) nano-sized powders with loadings ranging from 0.1 to 1.0 wt% were investigated as reinforced agents for polymethyl methacrylate (PMMA) bone cements. The mechanical properties (i.e. bend strength, bend modulus, compression strength, fracture toughness and fatigue performance) and the thermal properties (i.e. maximum temperature, setting time, curing heat and residual monomer) of the resultant nanocomposites were characterised. The mechanical performance of G-PMMA and GO-PMMA bone cements has been improved at low loadings (< 0.25 wt%), especially the fracture toughness and fatigue performance. These improvements were attributed to the fact that the G and GO induced deviations in the crack fronts and hampered crack propagation. The high functionalisation of GO compared with G resulted in higher enhancements because it facilitated the creation of a stronger interfacial adhesion between the GO and PMMA. The use of loadings < 0.25 wt% showed a detriment in the mechanical performance as consequence of the formation of agglomerates as well as to an increase in the porosity. The increase in the residual monomer and the decrease in the curing heat, observed with the increase in the level of G and GO added, suggests that such materials retard and inhibit the curing reaction at high levels of load by interfering in the radical reaction.**

**Index Terms— PMMA bone cement; Graphene; Mechanical properties; Fatigue properties; Fracture toughness**



**Citation:**
*Paz, E.; Forriol Campos, F.; del Real-Romero, J.C.; Dunne, N.; "Graphene oxide versus graphene for optimisation of PMMA bone cement for orthopaedic applications", Materials Science & Engineering C-Materials for Biological*

*Applications, vol.77, pp.1003-1011. August, 2017.*