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Preparation, Structure, Thermal and Mechanical Properties of New Poly(oxymethylene) – Clay Nanocomposites by Melt Processing: Effect of Silicate Type, Size, and Organic Modification on the Hybrid Properties

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Abstract

New intercalated and novel partially exfoliated nanocomposites of Poly(oxymethylene) {POM, Acetal resin} are prepared using sodium montmorillonite (MMT), organomontmorillonite and laponite clays, by the melt processing route. Processing conditions such as batch mixing speed, time and temperature were varied and optimized in order to obtain stable nanocomposites under most desired operating conditions. POM intercalates into Na^+MMT to separate the clay layers by 7 Å. Specific organic modification to montmorillonite rendered the silicate sufficiently organophilic but maintaining the polar interactions between POM chains and organic modifier surfactant, thereby leading to significant levels on intercalation (effect d-spacing shifts approx. 20 Å and 7 Å resp. for the organoclays studied). Partial exfoliation was also observed in the case of nanocomposites formed using dioctadecyl diethoxy quaternary ammonium exchanged montmorillonite). POM nanocomposite was fully exfoliated when nanometer sized clay laponite was employed. Melting temperatures (T_m) of the nanocomposites are comparable to that of crystalline POM and remain unaffected as a function of clay type and size. Significant increase in crystallization temperature as compared to unfilled POM is observed by formation of nanocomposites for all clays. Enthalpy of melting is significantly higher for the nanocomposites as compared to POM. The nanocomposites are thermally more stable as seen from TGA (weight loss on heating) results. Tensile and impact properties were also studied using injection molded specimens via DSM microcompounder. Higher tensile modulus for nanocomposites as compared to POM is observed, the modulus increasing with clay wt%. Impact strength is lower for the nanocomposites and decreases with increasing clay loading. Comparison of results for POM nanocomposites with preliminary results on intercalated nanocomposites of coacetal resin {Poly(oxymethylene-co-ethylene oxide)}will also be made. Wherever possible, our results for POM and POMEO nanocomposites will also be compared to the well studied PEO-clay nanocomposites in the literature.