INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Fabrication and Characterization of Poly(methyl methacrylate) (PMMA) Nanocomposites with Organically Modified Montmorillonite (MMT) and Layered Double Hydroxides (LDHs)

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SHORT ABSTRACT

This work reports the fabrication and characterization of PMMA nanocomposites using various nanofillers such as nanoclay (MMT), Co-Al LDH, Cu-Cr LDH and Ni-Al LDH. The melt intercalation and solvent blending techniques were employed for the preparation of PMMA nanocomposites. The properties of PMMA nanocomposites were evaluated by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), field emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), dynamic mechanical analyzer (DMA), atomic force microscopy (AFM), tensile, flexural strength, hardness, flammability and rheological analysis. The PMMA/clay (5 wt.%) nanocomposite prepared with PS-g-MA compatibilizer via melt intercalation method displayed relatively better mechanical properties over pristine polymer and other nanocomposites prepared using PP-g-MA and PE-g-MA as a compatibilizer. The results clearly expressed that PS-g-MA compatibilizer promotes adequate interface adhesion between the nanoclay and polymer matrix. Since the incorporation of nanoclay in the PMMA matrix was not enhanced the mechanical properties appreciably, therefore an attempt has been made to fabricate layered double hydroxides (LDHs) based PMMA nanocomposites (PMMA/Co-Al LDH, PMMA/Cu-Cr LDH and PMMA/Ni-Al LDH) containing various concentration of LDHs (1-7 wt.%) via melt intercalation and solvent blending methods. The results clearly pointed out that PMMA/Co-Al LDH nanocomposites prepared via melt extrusion exhibited better properties over Cu-Cr LDH based nanocomposites. The maximum improvement in tensile, flexural and impact strength was achieved by the addition of 1 wt.% LDH in the PMMA matrix, which was found to be 22, 24 and 10 % higher for Co-Al LDH based nanocomposite over neat PMMA, respectively. The XRD and TEM results suggested that both the preparation methods produced intercalated morphology for clay based nanocomposites and exfoliated structure for LDH based nanocomposites with lower loading of LDHs. It is evident from TGA data that the nanocomposites prepared via both routes demonstrated significantly improved thermal stability (about 31-35 ^oC and 26-32 ^oC for Co-Al, Cu-Cr LDH based nanocomposites, respectively) over neat PMMA due to the barrier effect of LDH layers, which limit the emission of produced gases. The glass transition temperature (T_g) was improved by 5 and 3 ^oC for PMMA/Co-Al LDH and PMMA/Cu-Cr LDH nanocomposite, respectively. The improvement of thermal stability of nanocomposites was also confirmed by increasing the activation energies (E_a) determined via Coats-Redfern method, which also

increased with increasing nanofiller loading. The reaction mechanism of thermal degradation of neat PMMA and respective nanocomposites was successfully predicted using Criado method. The findings of rheological investigations elucidated that the storage and loss modulus increased with an increase in the nanofiller content. Among the samples synthesized by solvent blending route, it can be concluded that the PMMA/Ni-Al LDH nanocomposites exhibited superior properties over Co-Al LDH and clay based nanocomposites. Although solvent blending technique generally contributes exfoliated morphology, it is limited to lab-scale process. Therefore, the PMMA/Co-Al LDH (1 wt.%) nanocomposite developed by melt intercalation would be the best candidate for various applications.