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Title : MISCIBILITY, CONDUCTIVITY AND INTERMOLECULAR INTERACTION STUDIES OF POLY(ETHYLENE OXIDE) AND POLY(METHYL METHACRYLATE) BLEND BASED NANOCOMPOSITE POLYMER ELECTROLYTES

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The addition of the third component into the polymer-salt system such as nanofiller has been extensively studied by researchers to increase the amorphous region of the polymer electrolyte system, thus improving the ion movement in the polymer chain. In most studies, the range of ionic conductivity of nanocomposite polymer electrolyte (NCPEs) can be up to $\sim 10^{-4}$ S cm $^{-1}$ and high σ_{DC} is recommended for use in applications. The success of the solid polymer electrolyte (SPEs) and NCPEs could be applied to energy storage device, electronic vehicle and capacitor for the future generation. However, the effective role of the nanofiller in promoting ion transport is not yet well understood. Therefore, this research is an effort to govern the understanding of the dispersion and effective role of the nanofiller of the most studied blend, Poly(ethylene oxide) (PEO)/Poly(methyl methacrylate) (PMMA) with lithium perchlorate (LiClO $_4$). Differential scanning calorimetry (DSC) was used to study the thermal behaviour of the SPEs and NCPEs. A single and composition-dependent glass transition temperature (T_g) is observed for all blend compositions with increasing content of PMMA in the blend and it follows closely to that of the Gordon-Taylor equation. Addition of TiO $_2$ does not give influence to the T_g s of PEO due to the absence of interaction between PEO and TiO $_2$, but significantly raises the T_g s of PMMA. Studies on crystallinity (X^*) shows that addition of PMMA and also TiO $_2$ cause distortion on the PEO spherulite shape. The reduction of dark regions in the inter-spherulite region indicates TiO $_2$ has weakened the linkage of O-Li through the Lewis acid-base interaction. Close inspection of the

SEM micrographs observe that at low TiO $_2$ content, the nanofiller is homogeneously dispersed with no nanoparticle aggregation in the salt-free and salt-added neat PEO as well as the PEO/PMMA blend matrix. Addition of LiClO $_4$ enhances the conductivity of PEO and it records a maximum σ_{DC} value of 1.38×10^{-6} S cm $^{-1}$ at $Y_S = 0.10$, then followed by PEO/PMMA 75/25 which exhibit σ_{DC} value of 7.00×10^{-7} S cm $^{-1}$ at the same amount of Y_S as PEO. In the presence of TiO $_2$, the σ_{DC} values of the salt-free neat PEO and neat PMMA remain unchanged with ascending nanofiller content. However, the σ_{DC} values of the PEO/PMMA 75/25 blend decrease by one order of magnitude. PEO/PMMA 75/25 at $Y_S = 0.10$ shows the shortest relaxation time (τ_{max}) among the blend composition. Overall, PEO/PMMA 75/25 blend system has the best ϵ' , ϵ'' , M' and M'' values which are very close to the respective values of the PEO system, thus accounts for its best ion conductivity among the rest of the blend systems investigated. The intermolecular interaction studies by FTIR have shown that addition of LiClO $_4$ causes the shifting of the characteristic peak in PEO, PMMA and its blend, however, the addition of TiO $_2$ has proved that the nanofiller is more active to the salt-added PEO/PMMA 75/25 system as compared to the parent polymers. The observation of crystal structure under XRD has shown that LiClO $_4$ and TiO $_2$ give effect on the crystal structure of PEO and PEO/PMMA blend, supporting the observation done by other instruments studied in this research.