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# Effect of $TiO_2$ on Viscoelastic Properties and Intermolecular Interaction of poly(ethylene oxide)/poly(*n*-butyl methacrylate)

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## Structured Abstract

**Background:** The viscoelastic properties and intermolecular interactions of poly(ethylene oxide) (PEO) ($Mw = 3.00 \times 10^5$ g mol$^{-1}$) and poly(*n*-butyl methacrylate) (PnBMA) ($Mw = 3.37 \times 10^5$ g mol$^{-1}$), with the addition of titanium dioxide ($TiO_2$) nanoparticles, were investigated. Thin films of the polymer blend nanocomposites were prepared using a solution casting technique with a different composition range (0/100 to 100/0). This study aimed to examine how different concentrations of $TiO_2$ influenced the viscoelastic properties and intermolecular interactions of PEO/PnBMA blends at different temperatures in a molten state.

**Methods:** The viscoelastic properties of the PEO/PnBMA/$TiO_2$ nanocomposites were analyzed at 80 °C and 140 °C using a rheometer (Anton Paar, Model: MCR 302) with 0.1% strain and a frequency range of 100–0.01 Hz as the parameters. Meanwhile, the intermolecular interactions were studied using the attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy with a diamond crystal window.

**Results:** Rheological studies conducted at 80 °C and 140 °C revealed that PEO-rich blends exhibited higher relaxation times and liquid-like behavior at low frequencies, while PnBMA-rich blends displayed solid-like behavior with lower relaxation times. The addition of $TiO_2$ increased modulus and relaxation time in PEO-rich blends but showed limited effects in PnBMA-rich blends due to phase interactions between the $TiO_2$ particles and the polymer matrix. Excessive $TiO_2$ (ranging from 4.0% to 5.0%) concentrations caused particle aggregation, reducing its reinforcement effectiveness. The power law analysis indicated significant deviations from ideal Maxwell behavior in both PEO- and PnBMA-rich blends, with the elastic component remaining partially unrelaxed, particularly at higher $TiO_2$ concentrations (4.0% and above). At 140 °C, increased molecular mobility reduced relaxation times for all compositions, while $TiO_2$ disrupted polymer chain mobility, shortening relaxation times further.

**Conclusion**: The findings showed that blending PEO with PnBMA reduced PEO's crystallinity, improving flexibility and controlled crystallization. The addition of $TiO_2$ nanoparticles enhanced the mechanical strength of the composites. However, excessive $TiO_2$ concentrations (above 4.0%) led to particle agglomeration, which reduced its reinforcement effectiveness by disrupting uniform dispersion and polymer interactions. This study provides valuable insights into nanoparticle-polymer interactions and demonstrates the potential of PEO/PnBMA/$TiO_2$ composites for industrial applications requiring tailored properties.

**Keywords:** Poly(ethylene oxide), Poly(n-butyl methacrylate), Titanium dioxide

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