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Analysis of apparent activation energy of shear viscosity of PVC/ZnO nanocomposite, at its phase transition temperature

Vishal Mathur [a,*], Pramod Kumar Arya [b], Manasvi Dixit [c]

[a] Department of Engineering, Sur University College, Oman
[b] Department of Mechanical Engineering, Icfai Tech School, The ICFAI University Jaipur, India
[c] Department of Physics, Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur, India

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ABSTRACT

The present paper deals with analysis of apparent activation energy of shear viscosity of PVC/ZnO nanocomposite, at its phase transition temperature. In this approach storage modulus (E′), loss modulus (E″), shear viscosity (η) and phase transition temperature (T_g) of the PVC and its ZnO nanocomposite are ascertained through Dynamic Mechanical Analyzer (DMA). The variation between log (η) versus (T_g/T) indicates the fragile behavior of the specimen that further depicts the nature of Arrhenius behavior of the specimen near its T_g. The slope of the curve between log (η) versus (T_g/T) characterizes as fragility that is numerically equals to apparent activation energy of shear viscosity, particularly at its phase transition temperature. The study reveals that the apparent activation energy of shear viscosity of PVC changes due to dispersion of ZnO nanofillers.

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1. Introduction

Polymer nanocomposites are among very attentive research field in recent years owe to their specific properties. Such composites exhibit properties of the multifunctional inorganic nanoparticles and polymers both that enable them to acquire unique mechanic processing along with flexibility characteristics of industrial polymers like polycarbonate (PC) [1], polyethylene (PE) [2], Polystyrene (PS) [3], poly vinyl chloride (PVC) [4] and poly methyl methacrylate (PMMA) [5], etc. L Yang et al. [6] successfully prepared PVC / $CaCO_3$ nanocomposite, by refluxing methyl vinyl silicone rubber (SR) and nano-CaCO3 particles in accordance with encapsulation model. They found that toughness of rigid PVC composite improved. P K Arya et al. [7] reported that thermomechnaical properties of neat PVC are improved due to dispersion of ZnO nanoparticles. A.A. Ebnalwale et al. [8] found that PVC/SiO_2 and PVC/ZnO nanocomposite specimens shows high refractive index and can be use as high refractive index optical lenses. Their study also concludes that PVC/Al_2O_3 nanocomposites are more appropriate for antireflection coating in solar cells. Y Zhang et al. [9] prepared PVC/TiO_2 nanocomposites by using injection-modeling method. They observed Vicat softening temperature, thermal stability, glass transition temperature and overall impact strength of the specimen improved. In this way the incorporated nanoparticles in the polymeric matrix, can be select in accordance their desired applications and properties.

Among these, Nano-ZnO revealed as multifunctional inorganic material with novel applications in plastic industry, medical packaging, cosmetics, medical devices, dentistry, and orthopedics, antibacterial coating, the textile industry, etc. owe to its various significant properties, like chemical stability, luminous transmittance, less dielectric constant, effective antibacterial, catalysis activity and intensive infrared and ultraviolet absorption [10]. Sh A Mansour et al. [11] reported significant improvement in electric breakdown strength in the finding of improvement of dielectric properties of PVC/ZnO nanocomposite for electrical appliances. Li Xihong et al. [12] revealed that ZnO nanoparticles has excellent potential for coating material property on a PVC thin film in antimicrobial packaging application against E. coli and S. aureus like bacterias. In view of these studies, the present paper focuses on the analysis of apparent activation energy of shear viscosity of PVC/ZnO nanocomposite, at its phase transition temperature that is essential to decide its end use application in designing physical appliances working in ambient thermal environment. In this

* Corresponding author.
E-mail address: wishalmathur@gmail.com (V. Mathur).

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