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STUDY OF THE VISCOELASTIC PROPERTIS OF POLYCARBONATE/ACRYLONITRILE-BUTADIENE-STYRENE ALLOY CONTAINING TRIPHENYL PHOSPHATE AND NANOCLAY AS FLAME RETARDANT

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Polycarbonate (PC) is commonly used as a high performance amorphous engineering thermoplastic due to its distinct properties such as high impact strength, transparency, heat resistance and dimensional stability, excellent electrical properties, colorability, high gloss, flame retardancy and high heat distortion temperature (HDT). On the other hand, it is notch sensitive and also difficult to process, since its high melt viscosity hinders the fluidity and the residual stress resulting from the process could cause fractures. To improve these, efforts have been made to develop polymer blends and alloys [1].
Acrylonitrile–butadiene–styrene (ABS) copolymer is the most popular rubber- toughened thermoplastic with several advantages, such as low cost, good process- ability, and low notch sensitivity, however, it suffers from a relatively low mechanical properties [1]. To overcome the problems with the mechanical properties and also HDT, it is common to blend ABS with other high performance engineering plastics such as PC. Since ABS has a T_g about 95 ^oC, addition of PC enhances the mechanical performance while improving HDT. The desired mechanical properties and HDT can be achieved by changing PC/ABS ratio.
Thermoplastics including PC/ABS blends are easily combustible and on the other hand have several applications in electronics, electrical and car industries where the plastic parts used must have a low flammability. Therefore, flame retardants (FRs) are added to reduce the probability of burning in the initial phase of the fire [1]. To achieve an optimum level of fire retardancy, a large amount of non-halogenated types, NHFR, (e.g. phosphates, ester phosphates, inorganic FRs,…) needs to be used in the formulation (NHFRs are used due to environmental considerations). However, the addition of large amounts of FRs could decrease the mechanical properties of resin [2] and also affects its rheological behavior [1]. In parallel, nanocomposites have attached considerable interest by the flame retardant polymer community since 1997 due to their improved fire properties [3]. It has been suggested that the presence of clay in a polymer can enhance the char formation providing a transient protective barrier and hence slowing down the degradation of the matrix [4]. However, when Polymer-Layered Silicate Nanocomposites (PLSNs) were evaluated by other testing methods using Limited Oxygen Index (LOI) and the vertical burning test (UL-94), do not perform better than the polymer without nanoclay [5]. Because of the aforementioned drawbacks in the application of conventional flame retardants and nanoclay individually, researches have been focused on their simultaneous use as flame retardant systems [5]. The objective of this research is to investigate the effect of the presence of TPP and nanoclay on the rheological properties and morphology of PC/ABS alloys. For this purpose, the variations of storage modulus (G'), Complex Viscisity (η^*) and tanδ with frequency (ω) for various blend systems are studied. The rheological behavior of the blends is then interpretated according to Carreau model [6]. In addition to PC, ABS and PC/ABS systems, the blends containing TPP, nanoclay and also TPP/nanoclay hybrid are used for this investigation. For this purpose, blends of PC/ABS with TPP, nanoclay and hybrid of TPP/nanoclay were investigated. The blends were prepared via a direct melt blending process in a twin- screw extruder.
PC/ABS blend showed a yield behavior in the complex viscosity curve in all range of frequencies, with values lower than PC and ABS. This proved a Negative Deviation Behavior (NDB) in the viscosity of this blend from log-additivity rule. High tanδ of PC/ABS blend and thus its lower melt elasticity confirmed this matter.
In TPP-contained formulations, the addition of TPP increased the melt viscosity but the storage modulus was not affected considerably. Also, with increasing TPP, melt elasticity and yield stress were decreased and the shear thinning behavior at medium and high frequencies was reduced. In nano-filled formulations, at low frequencies, with increasing nanoclay content the viscosity was increased whereas at high frequencies this was reversed. Also, the addition of even small quantities of nanoclay led to a non-Newtonian behavior with a significant increase in viscosity especially at low frequencies. A plateau modulus was observed at low frequencies indicating the formation of a network structure by the nanoclay particles. With increasing nanoclay content the

melt elasticity of PC/ABS blend was increased. In hybrid blends containing both nanoclay and TPP, it was concluded that the rheological behavior of the blend is mainly controlled by the presence of nanoclay rather than TPP. From the Cole-Cole diagrams an improved elasticity and ease of processing was concluded for the hybrid system.
XRD results proved an intercalated structure for nano-filled systems. This was supported by TEM image. Also, an improved intercalation was achieved in presence of TPP.

References

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