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Seminar title:

"GLASS TRANSITION AND POLYMER DYNAMICS IN POLYMER NANOCOMPOSITES"

Abstract

Glass transition and polymer dynamics of polymer nanocomposites, in particular segmental dynamics (α relaxation), associated with the glass transition, are topics of intensive research in recent years, aiming to better understanding of properties improvement in polymer nanocomposites and, thus, to knowledge-based design of better materials [1]. After an introduction into these topics and a survey of the overall behaviour, the results obtained on a particular system with poly(dimethyl siloxane) (PDMS) or natural rubber (NR) as matrix and silica or titania as filler, generated by sol-gel techniques in the presence of the polymer matrix, will be presented and discussed in more detail. FTIR was used to check the chemistry of synthesis and of polymer-filler interactions and TEM to study the morphology, in particular the quality of filler dispersion. The results obtained by a combination of differential scanning calorimetry (DSC), broadband dielectric relaxation spectroscopy (DRS), thermally stimulated depolarization currents (TSDC) and dynamic mechanical analysis (DMA), show that the presence of nanoparticles suppresses crystallization of the PDMS matrix, more pronounced in the case of titania. The glass transition temperature, T_g, remains practically unaffected, however a significant fraction of the polymer makes no contribution to the glass transition, as indicated by the reduction of the heat capacity jump [2]. The thickness of the corresponding interfacial layer is calculated to about 2 nm in the case of silica against 3-5 nm in the case of titania. This fraction of "immobilized" polymer gives rise to a slower segmental dynamics in the dielectric measurements, as compared to bulk dynamics. On the other hand, DMA shows overall and moderate effects of the filler on the glass transition and provides insight into correlations between polymer dynamics and thermomechanical behaviour [3]. The correlation of these results to type of filler and morphology and their implications to mechanical performance are discussed.

1. S. K. Kumar and R. Krishnamoorti, Ann Rev Chem Biomol Eng 2010.1:37-58
2. P. Klonos et al. Polymer 51 (2010) 5490-9
3. D. Fragiadakis and P. Pissis, J Non-Cryst Solids 353 (2007) 4344-52