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PVDF-Clay Nanocomposites: Effect of Clay on the Phase Behavior of PVDF

T. Umasankar Patro, Milind V. Mhalgi, Devang V. Khakhar, *Ashok Misra

Department of Chemical Engineering, Indian Institute of Technology Bombay, Powai, Mumbai-400076, India

Recently, polymer-clay nanocomposites have gained a considerable interest of research because of their superior mechanical, thermal and gas barrier properties as compared to their conventional microcomposites and pure polymers. Poly(vinylidene fluoride) (PVDF) is semi-crystalline polymer and has four crystal polymorphs namely, alpha, beta, gamma and delta; which are present in samples prepared under different conditions. Amongst the various phases, the beta-phase is the most important from technological point of view. The objective of the present study is to investigate the effect of addition of nanoclay on structure and properties of PVDF. Poly(vinylidene fluoride)-layered silicate nanocomposites were prepared by melt-mixing method in a twin-screw compounder using unmodified and organically modified montmorillonite clays. The structure of the resulting nanocomposites was studied by WAXD. The absence of (001) peak in WAXD indicates the delamination of clay layers, thus confirming the formation of nanocomposites. Hot-stage optical polarizing microscopy showed that the clay acts as nucleating agent in PVDF matrix, resulting in very tiny spherulites. DSC of nanocomposites indicated a slight decrease in crystallinity, but the crystallization and melting temperature increased reasonably. It is noted that the addition of small amount of clay (as low as 2 wt%) leads to the formation of beta-PVDF, as evidenced from WAXD and FTIR techniques. There is a marginal increase in tensile strength and modulus of resulting nanocomposites, whereas the elongation at break increased substantially by c.a. 200%. This shows that with addition of nanoclay, a significant increase in toughness is obtained. DMA results showed that there is an increase in the storage modulus. Nanocomposites were also prepared using clay with different organic modifiers to study the effect of these modifiers on the formation and extent of beta-phase along with its mechanical properties.