Effects of feeding route and state of cure upon percolation threshold and rheological behavior of electrically conductive dynamically vulcanized PP/EPDM/expanded graphite Nanocomposite

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Electrically conductive thermoplastic vulcanizates (TPV) nanocomposites based on polypropylene (PP), ethylene-propylene-diene rubber (EPDM), maleic anhydride grafted polypropylene (PP-g-MA) and maleic anhydride grafted EPDM (EPDM-g-MA) as compatibilizers, and expanded graphite (EG) have been successfully prepared via dynamically vulcanization of the EPDM phase during melt mixing process in an internal mixer. The influence of the feeding route upon partitioning of the conductive expanded graphite nanolayers between PP matrix and dispersed EPDM phase, and hence conductivity percolation threshold (σc) has been investigated. Correlation between the TPV morphology developed during various times of dynamic vulcanization process (SOC) and conductivity threshold has also been studied. Results showed that incorporating EG in the form of masterbatch with compatibilizers leads to the longer conductivity threshold (> 5 vol %) compared with direct melt blending (3.5 vol %). This was found to be attributed to the encapsulation of the EG by EPDM phase as well as nanolayers breakdown during long time of mixing process, and hence retardation of the formation of conductive networks throughout the PP matrix. This was consistent with the lower dynamic melt elastic modulus (G’) with less non-terminal behavior measured by RMS for the TPV nanocomposites prepared by pre-blending method. Higher residing of EG in EPDM phase when it was masterbatched with EPDM-g-MA was evidenced by micro-morphological development during dynamic vulcanization of the blend. Conductivity showed to be dependent on the state of cure (SOC) once conductive system was incorporated.