ABSTRACT

This thesis aims to develop peroxide crosslinked ultra-high molecular weight EPDM (UHMW-EPDM) rubber based thermoplastic vulcanizates (TPVs) with superior durability for different automotive applications. TPVs were prepared with various fillers or nano-fillers, like: nano-clay, nano-silica and conductive carbon black (CCB) to enhance the mechanical, rheological properties etc. The development of droplet type morphology in presence of fillers and structure-property relationships were studied. Initially all the TPVs and TPV nano-composites (TPVNs) were prepared by conventional melt mixing techniques at high temperature. Later the mixing process was optimized and the co-agent master batch technique was followed for the TPVs and conductive TPVs (CTPVs) preparation. The developed TPVs, TPVNs and CTPVs were characterized for mechanical, thermo-mechanical, electrical, rheological and morphological properties. Hence, the nano-clay and nano-silica were incorporated to enhance the mechanical and rheological properties and the influence of the nano-fillers were examined. The SAXS study reveals the better dispersion of the nano-silica than nano-clay in the TPVN matrix. The FE-SEM and AFM micrographs prove the droplet or finer dispersed morphology has been obtained for the nano-silica based TPVNs, whereas the nano-clay filled TPVNs formed elongated morphology. Since the co-agents play a major role in TPVs performance properties, different types of co-agents (TAC, HVA2, ZDMA, ZMA) have been explored. Besides that, the TSSR measurement was also conducted to investigate the thermo-mechanical behaviour of the TPVs. TSSR study, mechanical and rheological properties study reveal the synergistic effect for the ZMA co-agent based TPV. Crosslink density obtained from the TSSR study was compared with the crosslink density, calculated from Flory-Rehner equation and found to exhibit same trend. Superior material strength (for ZMA co-agent based TPV) was also confirmed from the stress relaxation study and thermal analysis. Mixing sequences control the product quality and production rate of the TPVs. The effect of different routes of mixing sequences on the mechanical properties and rheological properties have been studied. The conventional melt blending method was compared with the different master batch blends and co-agent master batch was found superior in mechanical and rheological properties over the others. The improvement in crosslink density was also found and the targeted droplet type morphology was achieved and specially this study optimizes the mixing method for future works. UHMW-EPDM rubber based flexible conductive materials also can be developed where there is a high demand of this type of materials for fabricating flexible or stretchable conductive devices. CCB filler was incorporated with UHMW-EPDM rubber to develop CTPVs. Impressive ac conductivity has been achieved for the CTPVs which makes the study more interesting. Besides that, improvement in mechanical and rheological properties was also found, and %EB, tear strength values optimize the flexibility level of the CTPVs. FE-SEM and AFM studies show the droplet type morphology formation of the crosslinked rubber phase whereas TEM study reveals the uniform dispersion of the filler in the TPV matrix. In short, TPVNs and CTPVs with improved properties were developed which can be used as various injection moulded parts, aesthetic seals/strips and 2K-moulds for the automotive applications and flexible conductive devices etc.

Keywords: *Polymer blends and alloys; Thermoplastic Vulcanizates; UHMW-EPDM; TSSR; Co-agent; Mixing sequence; Conductive Carbon Black; Automotive product*

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