Development of Novel Ionic Thermoplastic Elastomer: An Approach Towards Green Routes of Crosslinking

Abstract

Cross-linking is an important step in any rubber product manufacturing process, it enhances the elasticity of rubber through the formation of a three-dimensional network structure. Unfortunately, the excellent properties of these cross-linked rubber compounds are associated with the practical impossibility of reprocessing these materials due to the severely restricted long-range motion of polymeric chain molecules. Therefore, the recycling of conventionally crosslinked elastomer products is one of the major research interest at present. For this purpose, we have intended to explore a “cradle to grave” approach. This approach in principle does not involve additional chemical processing step, and neither results in any degradation of the cross-linked elastomer after recycling. For example, molecular recognition routes, such as H- bonding, metal coordination, van der Waals forces, or π-π interactions, do not involve covalent bonding between two or more polymeric chain molecules. Incorporation of such interactions into the rubber matrix enhances the initial attributes of sole elastomers. Herein, we report a network of maleic anhydride grafted ethylene propylene (M-EPM) rubber, cross-linked by the ionic interactions of transition metal complexes with naturally occurring amino acid such as L-Lysine and L-Tryptophan, which combines better tensile strength, high stretchability, and reprocessability aspects. At appropriate temperature, such cross-linked M-EPM rubber can be easily reprocessed without compromising physical properties. In a detailed study, we have thoroughly discussed zwitterion’s special attribute that compatibilize polar materials such as nylon into EPM rubber's elastomeric matrix. Such EPDM/Nylon based TPE should be used in a wide range of application. This dissertation also includes some computational studies such as molecular dynamics, FEA analysis, and machine learning applications, which add new possibilities for exploring recyclable ionic TPEs.