

Abstract

Unmodified and chemically modified poly [styrene-(ethylene-co-butylene)-styrene] (SEBS)-montmorillonite clay based nanocomposites have been prepared and characterized in the thesis. The investigations have focused on improving the physico-mechanical properties and structure-property relationship of SEBS-clay nanocomposites at very low concentration. The first part of the thesis emphasizes triblock SEBS copolymer based thermoplastic elastomer - clay nanocomposites in both solution cast and direct melt processes, employing unmodified hydrophilic (MT) and organically modified hydrophobic montmorillonite clays (OMT). Detailed microstructure by atomic force microscopy (AFM), transmission electron microscopy and X - ray diffraction alongwith physico-mechanical, dynamic mechanical, thermal and optical properties for neat SEBS and its clay based nanocomposites have been determined. Comprehensive morphological characterization of the domain thickness, roughness, and quantification of hard-soft phases and localized forces in the particular domains by using of force-distance measurements by AFM has been attempted. The other part of the thesis delineates the effect of grafting of polar organic moieties (acrylic acid, maleic anhydride and sulphonic acid) onto SEBS backbone that generate different morphologies and enhance hydrophilic interaction with cheaper unmodified montmorillonite nanoclay. Synthesis, morphological investigation and analysis of dynamic mechanical and thermal properties, water-methanol mixture uptake and permeation, and AC resistivity have been carried out for sulphonated SEBS and their MT clay based nanocomposite. Finally, microstructures of all developed nanocomposites have been analyzed by using small angle X-ray scattering and modulated differential scanning calorimetry studies.

Keywords: *Nanocomposite, SEBS, Montmorillonite clay, Atomic Force Microscopy, Morphology, Modification, Physico-mechanical properties*

Contribution of the candidate

List of Publications on PhD work

1. *Thermoplastic elastomeric nanocomposites from poly (styrene- ethylene-co-butylene- styrene) and clay: Preparation and Characterization:* [Anirban Ganguly](#), M. DeSarkar and Anil K. Bhowmick, *Journal of Applied Polymer Science*, 100, 2040, (2006).
2. *Morphological mapping and analysis of poly (styrene-b-ethylene-co-butylene-b-styrene) block copolymers and their clay nanocomposites using atomic force microscopy:* [Anirban Ganguly](#), M. DeSarkar and Anil K. Bhowmick, *Journal of Polymer Science: Part B, Polymer Physics*, 45, 52 (2007).
3. *Surface force quantification of poly (styrene- ethylene-co-butylene- styrene)-clay nanocomposites through atomic force microscopy:* [Anirban Ganguly](#) and Anil K. Bhowmick, *Journal of Applied Polymer Science*, (revised paper under consideration for publication).
4. *Effect of polar modification on the morphology and properties of styrene-ethylene-co-butylene- styrene triblock copolymer-montmorillonite clay nanocomposites:* [Anirban Ganguly](#) and Anil K. Bhowmick, *Rubber Chemistry and Technology*, - under review.
5. *Sulphonated styrene-(ethylene-co-butylene)-styrene/ montmorillonite clay nanocomposites: synthesis, morphology and properties:* [Anirban Ganguly](#) and Anil K. Bhowmick, *Nanoscale Research Letters*, NANO EXPRESS, 3, 36 (2008).
6. *Insights into montmorillonite nanoclay based ex-situ nanocomposites from SEBS and modified SEBS by SAXS and MDSC studies:* [Anirban Ganguly](#), Yongjin Li and Anil K. Bhowmick, *Macromolecules*, Accpeted for publication, 2008.
7. *Factors influencing the morphology and the properties of clay-rubber nanocomposites:* A.K. Bhowmick, [Anirban Ganguly](#) and M. Maiti, *Kautschuk Gummi Kunststoffe*, 59, 437 (2006).

Papers Presented in Conferences

1. “Effect of polar modification on the morphology and properties of styrene -ethylene-butylene-styrene triblock copolymer –montmorillonite clay nanocomposites”: [Anirban Ganguly](#) and Anil K. Bhowmick, ACS Rubber Division, 170th Fall Technical Meeting and Rubber Mini Expo '06, at Cincinnati, Ohio, USA 10-12 October, 2006. Received best Graduate Poster Award in the world by American Chemical Society. <http://www.rubber.org/meetings/studentcolloquium/2006.htm>
2. “Effect of acrylic acid grafting on the morphology and properties of styrene -ethylene-butylene- styrene triblock copolymer –montmorillonite clay nanocomposites” [Anirban Ganguly](#)

and A. K. Bhowmick , *International Conference on Recent Trends in Nanoscience and Technology (ICRTNT-06)*, 7-9 Dec., 2006, Jadavpur University, Kolkata.

3. Poster on “Effect of polar modification on the properties of transparent SEBS- clay nanocomposites”, [Anirban Ganguly](#) and A. K. Bhowmick , ‘*MACRO 2006- Polymers for Advanced Technologies*’, 17–20 December, 2006, National Chemical Laboratory, Pune, India.
4. “AFM studies on block co-polymeric nanocomposites” International Conference on Nanomaterials: [Anirban Ganguly](#) and A. K. Bhowmick, 4-6 Nov., 2004, MRSI, Kolkata, India.
5. “Structure-property relationship of sulphonated SEBS – clay nanocomposites – with reference to applications”, [Anirban Ganguly](#) and Anil K. Bhowmick, *International Conference on Rubber & Rubber-Like Materials (ICRRM)*, 8-10 Jan., 2008, IIT Kharagpur.

Book Chapter

[Anirban Ganguly](#), J.J. George, S. Kar, A. Bandyopadhyay and A. K. Bhowmick, in ‘Rubber nanocomposites from miscellaneous nanofillers’ Chapter 4 in the book : *Current Topics on Elastomers Research*, Ed. A. K. Bhowmick, March 2008, CRC Press, USA.