Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 2, Number 15; April-June, 2015 pp. 1263-1265

http://www.krishisanskriti.org/jbaer.html

"NANOCOMPOSITE BASED ON MONTMORILLONITE NANOCLAY REINFORCED ETHYLENE PROPYLENE DIENE MONOMER/SILICONE RUBBER BLENDS"

Ravi Pratap Singh[1*], K. N. Pandey[2], Vishal Verma[3], Abrar Ahamad[4] and R. M. Mishra[5]

[1,2,3,4,5]*Central Institute of Plastics Engineering and Technology, Lucknow, India-226008*
E-mail: [*]katiyarravi3@gmail.com

Abstract—*EPDM/silicone rubber nanocomposites have been prepared by incorporating various loading (1, 3, 5, 7, phr) of MMTs nanoclay onto EPDM and silicone rubber (VMQ) blends using melt mixing process by two roll mill. Effect of MMT content on mechanical, thermal, and morphological properties of the nanocomposites are investigated .Mechanical properties such as tensile strength, tensile modulus & hardness were tested. Thermo gravimetric analyzer (TGA) analysis is carried out to analyze the thermal stability of the nanocomposites. The results of mechanical properties such as tensile strength, modulus, elongation at break and hardness etc, have remarkably increased with the incorporation of nanofiller in rubber matrix has been found to be maximum at 5 phr loading of nanofiller. The improvisation in various properties can be attributed to better interfacial adhesion between reinforcement and rubber matrix. SEM micrographs demonstrate better dispersion of MMT in the blend matrix. The thermal stability of blend system remarkably shows and appreciably enhancement due to better interfacial adhesion between the MMT and Polymer Matrix.*

Keywords*: Silicone rubber, EPDM, Nanoclay, Tensile Strength, Thermal properties.*

1. INTRODUCTION

Nanocomposite is a material in which polymer matrix reinforced by nanofiller having dimension < 100 nm [1-2]. In the present scenario nanocomposites are novel materials and they are playing vital a role in material science and technology. Nanocomposite has been offering superior properties, such as strength and moduli [3-5], decreased thermal expansion co-efficient, enhanced ionic conductivity, decreased flammability, toughness and barrier properties [7-8], compared to conventional composites. They offer these properties due to the nanoscale dispersion of the nano reinforcement material within the polymer matrix and efficient interfacial adhesion between the polymer and nano filler. Various nano composites have been prepared based on carbon black, carbon nanotubes, exfoliated graphite, nano crystalline metals [9] etc. Ethylene propylene diene monomer (EPDM) is an unsaturated polyolefin rubber which has attracted much attention for outdoor applications such as automotive sealing systems. Silicone rubber delivers the excellent strength, and temperature resistance from-60^{o}C to+260^{o}C and durability needed under the bonnet and helps to provide crushing thermal resistance and mechanical properties, load bearing and protective shock absorption qualities to automotive interiors [10-11].

In the present work, a binary blend of EPDM /silicone rubber has been prepared by melt blending process using two roll mill. Modified MMT has been used as a nanofillers are dispersed in the EPDM/silicone rubber blend system. The influence of modified MMT at various loadings on the thermal, mechanical and morphological properties of the binary blend system has been studies**.**

2. EXPERIMENTAL

2.1 MATERIALS

The following ingredients were used in the present work:

EPDM rubber: EPDM (KEP-960) having the specific gravity of 0.87 and a Mooney viscosity of 49(ML 1+4 at 125^{0}C) with ethylene content = 70 wt.% , propylene content = 23.85 wt.% and ethylene norbonenen of 5.7 wt.% was provided by Kumho Polychem. Co. Ltd., Korea.

Silicone rubber: VMQ (Silastic NPC-40) having the specific gravity of 1.11 gm. /cm3 was provided by Dow Corning (USA).

MMT Nanoclay: Organo modified montmorillonite (OMMT) clay: Nanomer® 1.31 PS, montmorillonite clay surface modified with 15-35 wt. % octadecylamine and 0.5-5 wt. % aminopropyl triethoxy silane supplied from Sigma Aldrich, (USA),was used as reinforcing agent to prepare the nanocomposites.

PREPARATION OF NANOCOMPOSITES: Blend of EPDM and silicone rubber was prepared by melt mixing equal weight percentages (50:50) of the materials in a two roll mill for about 15 minutes at room temperature. Silica gel of required quantity was incorporated to the blend and mixing was continued for 10 minutes.

Table 1: Sample code and compounding formulation of EPDM/silicone rubber nanocomposite.

Sample Codes	EPDM	Silicone rubber	Silica gel	MMT (phr)	Dicumyl peroxide
A	50	50	25	-	5
B	50	50	25	1	5
C	50	50	25	3	5
D	50	50	25	5	5
E	50	50	25	7	5

For the preparation of EPDM/Silicone rubber nanocomposites with various content of MMT, required quantities (0, 1, 3, 5 and 7 phr) were incorporated by mixing the blend in the two roll mill for about 5-10 minutes at room temperature. Then dicumyl peroxide was added and mixed for about 5 minutes. The vulcanization of the rubber compound was carried out in a hydraulically operated press at 150°C for 10 minutes. The vulcanized samples were post-cured at 140°C for 1hr in an air-circulating oven. Test specimens were punched out from the compression-moulded sheets. The nanocomposites prepared with various compositions (Table 1) were tested for their mechanical, morphological and thermal properties.

3. EVALUATION OF PROPERTIES

MECHANICAL PROPERTIES Mechanical properties such as tensile strength, tensile modulus and elongation at break were measured by using a universal testing machine of the INSTRON model 3382; USA with the maximum load capacity 100 KN.. It has also been observed that both tensile modulus and elongation at break increases. The unit of hardness is expressed in Shore-A Durometer as per ASTM D 2240.

4. THERMO GRAVIMETRIC ANALYSIS (TGA)

Thermo gravimetric analyzer studies has been conducted by using a Perkin-Elmer Pyres TGA, in the temperature range of 50-650°C under a constant heating rate of 10°C/min in nitrogen atmosphere for thermal stability studies of the developed nanocomposites.

5. RESULTS AND DISCUSSIONS

MECHANICAL PROPERTIES The effect of MMT content on the mechanical properties of EPDM/Silicone rubber nanocomposites was analysed and the values are presented in Fig (1-4). From the Fig. 1 & 2, the maximum value of tensile strength and tensile modulus is observed for the nanocomposite containing MMT loading of 5 phr.

From fig. 2 and 4, elongation at break and hardness of EPDM/Silicone rubber nanocomposites was found at 5 phr loading of MMT nanoclay.

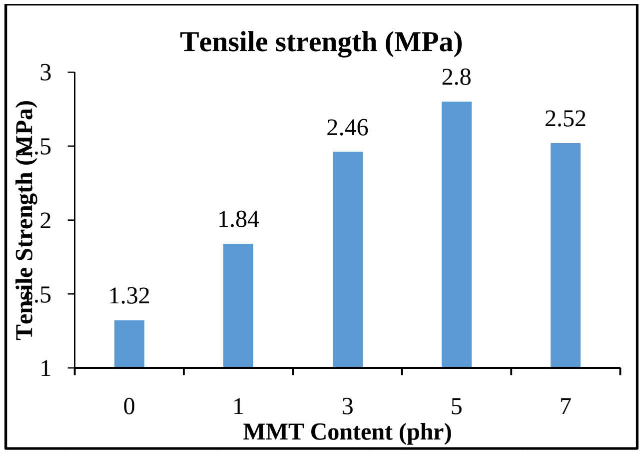

Fig. 1: Effect of MMT content on Tensile strength of EPDM/Silicone rubber nanocomposites.

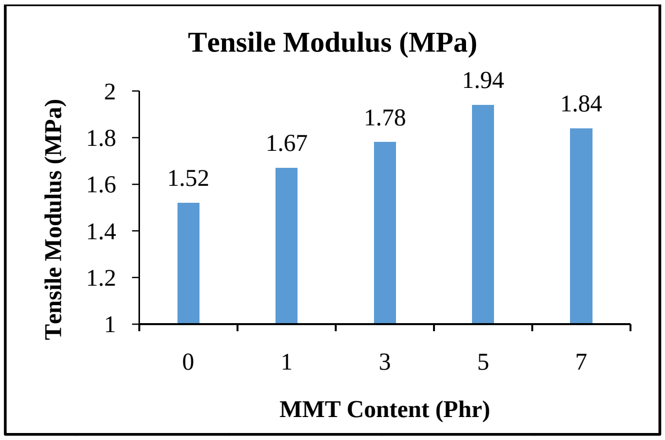

Fig. 2: Effect of MMT content on tensile modulus of EPDM/Silicone rubber nanocomposites.

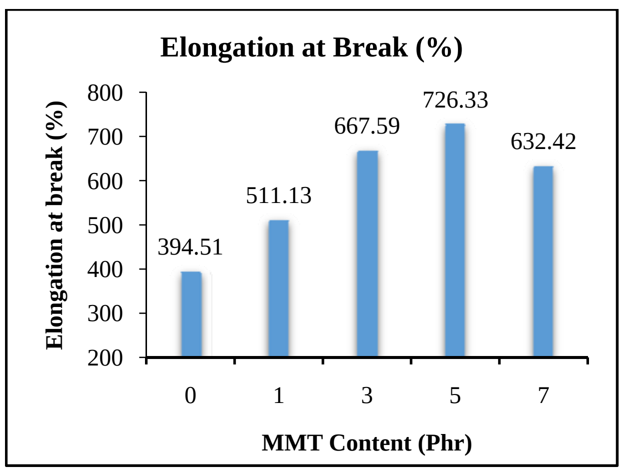

Fig. 3: Effect of MMT content on elongation at break of EPDM/Silicone rubber nanocomposites.

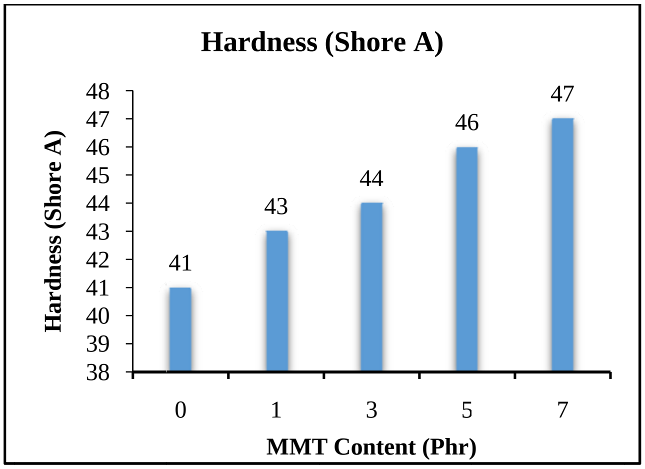

Fig. 4: Effect of OMMT content on Hardness of EPDM/Silicone rubber nanocomposites.

6. THERMO GRAVIMETRIC ANALYSIS (TGA)

TGA thermogram obtained for the nanocomposites are presented in Fig 5. TGA thermogram showed that the thermal stability of nanocomposites increases with increasing OMMT loading, which shows the ability of nanofiller in retarding the heat diffusion into the rubber matrix. In Fig 5, the temperature at which minimum decomposition takes place is plotted against the MMT content. The Fig. shows the improvement in thermal stsbility of nanocomposites when MMT content increased. This improvement attributes the delay in diffusion of volatile decomposition products from the nanocomposite structure.

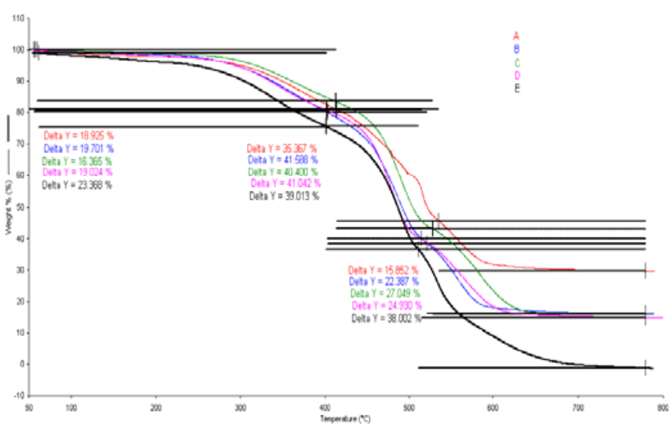

Fig. 5: TGA thermogram of EPDM/silicone rubber nanocomposites.

7. CONCLUSIONS

The nanocomposites based on EPDM/silicone rubber filled with various loadings of MMT nanoclay have been prepared in two roll mill by melt mixing process. It has been found that MMT nanoclay in the polymer matrix shows the prominent effect on the performance of polymer nanocomposites, due to better dispersion of nanoclay. Better dispersion of MMT results in the enhancement of thermal and mechanical properties of nanocomposites when compared with pure blend of EPDM/silicone rubber.

REFERENCES

[1] Komameni S., J. Mater. Chem., 2(1992)1219.

[2] Glitter H., Adv. Mater. 4(1992)474.

[3] Novak B. M., Adv. Mater., 5(1993)422.

[4] Ziolo R. F., Giannelis E.P., Weinstein B.A., Ohoro M.P., Ganguly B. N., Mehrotra v., Russell M. W., and Hoffman D. R., Science, 257 (1992)219.

[5] Utracki L. A., clay-containg polymeric nanocomposites, vol, 2, Rapra Shawbury, 435 (2004).

[6] P. Bharadwaj, Pratibha Singh, K.N. Pandey, Vishal Verma, and S.K.Shrivastav., Applied Polymer composite, vol. 1 No. 4 2013.

[7] Vijayalekshmi.V, Abdul Majeed.S.S.M / International Journal of Engineering Research and Applications (IJERA) Vol. 3, Issue 2, March -April 2013, pp.1177-1180, Mechanical, Thermal and Electrical Properties of EPDM/Silicone blend Nanocomposites

[8] Raja Prabu R, Usa S, Udayakumar K, Abdul Majeed S.S.M, Abdullah Khan M, 'Electrical insulation characteristics of Silicone and EPDM Polymeric blends-Part I', *IEEE Transactions on Dielectrics and Electrical insulation Vol.14, No.5*, October 2007,1207-1214.

[9] Jeffry Mackevich, Minesh Shah, 'Polymer outdoor insulating materials Part-I: Comparison of Porcelain and Polymer electrical insulation', *IEEE Electrical insulation magazine, Vol.13, No.3*, May/June 1997, 5-10.

[10] Stephane Simmons, Jeffry Mackevich, Minesh Shah, Chang R.J, 'Polymer outdoor insulating materials Part-III: Silicone Elastomer considerations', *IEEE Electrical insulation magazine, Vol.13, No.5*, September/October 1997, 25-32.

[11] Ehsani M, Borsi H, Gockenbach E, Bakhshandeh G.R, Morshedian J,Abedi N, 'Study of Electrical, dynamic mechanical and surface properties of silicone – EPDM blends', *IEEE International conference on solid dielectrics*, Toulouse, France, July2004, 5-9