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IASET

"SYNTHESIZE AND CHARACTERIZATION OF ELASTOMERIC COMPOSITE"

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ABSTRACT

Nanocomposites of natural rubber and carboxy methyl cellulose fully interpenetrating polymer network have been prepared for high performance elastomeric engineering applications. Natural rubber is an excellent elastomeric material with better stability. It cannot be used for any specific applications due the poor thermal stability. The stability of natural rubber can be enhanced by vulcanizing rubber with suitable cross-linking agents and activators. Vulcanization of rubber using Sulphur and peroxide are the main methods adopted in rubber industries to improve the stability. Very recently, a new system to vulcanize rubber-using glutaraldehyde has been introduced. According to this method, rubber vulcanizes at very low temperature compared to other conventional methods.

Blending of polymer is an easy way to develop material with desired physical properties. Simple blends show phase separation and immiscible nature. For immiscible blends, addition of common cross linking agent for both the polymers enhances the strength considerably. The formation of three-dimensional network between two phases increases the stability. The resulting materials become an interpenetrating polymer network. In the present study, interpenetrating polymer network has been prepared by using natural rubber and carboxy methyl cellulose. Glutaraldehyde plays a major to vulcanize or crosslink both the phases simultaneously. Nano silica is used as the filler for the preparation of Nano composites by using latex blending method. The resulting samples have been introduced for mechanical characterization.

It is found that, the addition of nanoparticle into the interpenetrating polymer network enhances the tensile properties and hardness. Such type of rubber-based materials can be used to develop elastomeric articles with higher stability.

KEYWORDS: Carboxy Methyl Cellulose, Immiscible Blends, Glutaraldehyde and Vulcanize

INTRODUCTION

Materials science is an interdisciplinary field wherein the properties of issue are connected to different regions of science and building. This field covers an extensive variety of materials, for example, metals, non-metals, polymers, composites, pottery, semi transmitters and so on. Composites and nanocomposites are another class of materials supplanting the regular materials, for example, metals, non-metals, earthenware production, glass and so forth

because of their upgraded properties and wide range applications.

Composite is a kind of material composed of in excess of one part as compared to another such as matrix and fiber reinforcement. These are strong with multiphase materials framed with the proper mixing of constituents of various auxiliary, physical and concoction properties. Composites may provide surprising mixture of fragment constituent properties, for example, weight, quality, firmness, porousness, electrical, decomposability and optical characteristics that is difficult to achieve freely by solitary segments.

Nanocomposites are broadly utilized in autos, aeronautical, gadgets, nourishment businesses, water treatment and some more.

In vehicles, nanocomposites can be utilized for:

- Reducing air contamination, producing light weight parts

- Better execution and motor proficiency

- Greater benefit life

- Safety and reusing capacity

- Increasing solace and adaptability

In aeronautical, nanocomposites can be utilized for:

- Purifying, functionalizing and polarizing Nano tubes

- Synthesizing electrically conductive and switchable atoms for self-warming

- Developing high quality to weight proportion and high effect nanocomposites

- Developing polymer nanocomposites for multifunctional use with tuneable electrical properties, development of warm and basic earthenware production, development of brilliant materials for push detecting and self-recuperating, radiation testing and portrayal of multifunction utilize rheology and hypervelocity affect testing. Each nanocomposite arranged has a positive application. Any nanocomposite created a specific application/prerequisite.

Materials and Methods

Synthesis of Carboxymethyl Cellulose

The carboxymethylation reaction consist two steps, NaOH treatment (basic chemical treatment) and etherification (dehydration of alcohol content from the ether) of cellulose under distinguished condition. For alkalization, 5% cellulose was suspended in isopropyl alcohol, and 20% NaOH was mixed to the mixture using mechanical/ manual stirring at room temperature for 1 hour to yield alkali cellulose. Etherification reaction was continued by the addition of SCA to the mixture for 30 min. It was left to stir and heated up to reaction temperature of 50°C for 4 hours. The mixture was terminated by adding alcohol. Carboxymethyl cellulose was then recovered by filtration and cleaned three times with methanol. Finally, the component was dried at 50°C in cabinet drier.

PROCEDURE TO MAKE SAMPLES

Composition Details

Depending upon the literature survey and review made in this work, the following combinations of NRL, CMC, GA and Silica were described with different ratios based on volume fraction calculated.

- NRL 35ml + CMC 0.2 g + 10ml of 10% GA + 0.05 Silica

- NRL 35ml + CMC 0.4 g + 10ml of 10% GA + 0.05 Silica

- NRL 35ml + CMC 0.6 g + 10ml of 10% GA + 0.05 Silica

- NRL 35ml + CMC 0.8 g + 10ml of 10% GA + 0.05 Silica

Sample Preparation

As per the ASTM standards around five number of test, (sample) specimens were prepared, and are tested as per the procedure described. Special care was taken in this test analysis since the elastomer is also a part of the procedure.

Prepared samples were stored in the air tight container to avoid environmental effects and it avoids the other unwanted chemical reactions in the prepared samples.

Preparation of First Sample

- Measure 35 ml of natural latex rubber and transfer to the beaker

- Add 20 ml of distilled water in to the beaker contains rubber solution and stirred well.

- Measurement of 10 % glutaraldehyde solution

- Add 10ml of 10 % glutaraldehyde solution and stirred well.

- Silica Nano particles (0.05silica).

- The beaker with water and Nano-particle is kept in ultra-sonicator for 20 minutes.

- Mix both the mixture solution uniformly

- Then the solution is kept in the hot air oven at 50° for 12 hours to evaporate water content percent in the composite solution.

- Peeling out Same process is done for next three samples by varying Carboxyl Methyl Cellulose mixture grams.

Procedure to make Samples with Carboxyl Methyl Cellulose

As it was discussed in the previous topic, in the preparation of samples with the Carboxyl Methyl Cellulose will also similar and some extra edition of some chemical/additives are discussed in detailed step by step procedure.

- Take 0.2 grams, in powder form of Carboxyl Methyl Cellulose (CMC)

- Take 35 grams of Natural Latex Rubber in beaker

- Pour this Natural Latex Rubber to dissolved Carboxyl Methyl Cellulose composition and stir well.

- Add 10 ml of 10% GA (Guttural Dehide) to beaker and stir well.

- Take 40ml of 25% GA solution is taken in the beaker by measuring it in the graduated cylinder. To this beaker, 60 ml of water is added constantly by adding water. Constant stirring is maintained to properly mix the mixture.

- Weigh the 0.05 grams of Silicon Nano powder APS 40nm.

- Place the nanocomposite solution in ultrasonic container to get the uniform mixing of nanoparticles in distilled water.

- After uniform mixing of solution, add this solution in to Latex rubber, Carboxyl Methyl Cellulose and 10 ml of 10% GA (Guttural Dehide) and stir well.

This solution of Nano particles of APS and distilled water is mixed to the solution prepared in the step 4 (Latex rubber + Carboxyl Methyl Cellulose solution) and step 5 (10 ml of 10% GA solution) and this mixture is stirred thoroughly.

- Pour the complete composition to suitable dish and identify the sample.

- Place this sample to oven with 50 Deg centigrade to 12hours.

- Then these dishes were kept inside the oven at a temperature of 50^{0}C for 12 hours to prepare the composites. All the different dishes containing different composition mixtures could be kept in one oven and all specimens were prepared in unique environmental conditions.

- After 12 hours take back this sample, remove the sample after cooled from dishes. Finally, a thin layer of Nano composite will be formed onto the petri dish in which mixture of LR + distilled water + 10 % glutaraldehyde solution + silica Nano particle mixture was kept. Then these composite layers will be peeled out from the petri dish and with suitable standards, the specimens will be introduced for different testing processes.

- Place this sample to plastic cover and mark the identification and keep it ready for testing.

RESULTS AND DISCUSSIONS

In this section tensile strength, elastic modulus, percentage of elongation and surface hardness of different specimens were discussed. Also, the effect of percentage of increament in the CMC was also described in detail.

Figure.1 show the tensile and hardness of Nano composite for various natural rubber and carboxy methyl cellulose blends. The tensile strength of rubber increases on vulcanizing rubber with glutaraldehyde. Formation of three-dimensional network within the material leads to improve the strength. Elongation at break is found to be reduced for vulcanized rubber. This is due to the formation of cross links between polymer chains and it restricts the movement of elastomeric chains. Reduction in elongation is mainly attributed due to the enhancement in tensile strength and modulus.
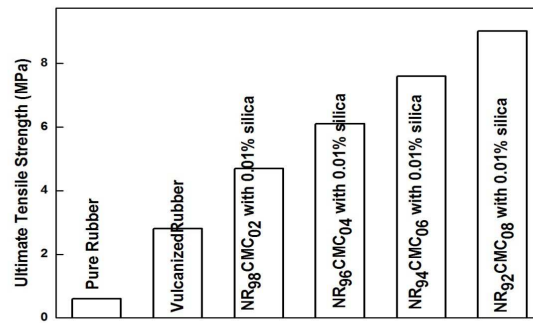
**Figure 1: Variation of Tensile Strength with the Addition of
CMC and Reinforcement of Nano-Silica.**

Figure 1 depicts the tensile strength values for the different materials fabricated in this work. Among all the fabricated composites, $NR_{92}CMC_{08}$ + 0.05% Nano silica exhibit higher tensile strength value (i. e. 9.02 MPa) and least value is recorded for specimen made from pure natural rubber (i.e. 0.6 MPa). From figure 4.1 it was observed that, vulcanization, addition of $CMC_{02, 04, 06 \text{ and } 08}$ along with 0.05% of silica will gradually increases (2.8, 4.7, 6.1, 7.6 and 9.02 MPa) the tensile strength respectively.
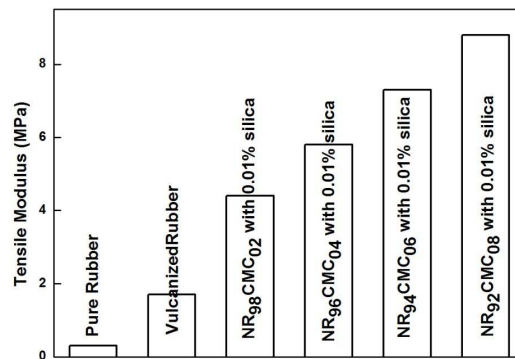
**Figure 2 Variation of Tensile Modulus with the Addition
of CMC and Reinforcement of Nano-Silica.**

Similar to the tensile strength values, tensile modulus was also depicted in the figure 2. And same trend as in Figure 1 was observed in the Figure 2 also. Tensile modulus value was goes on increasing as the percentage of CMC increases and NR percentage reduced. It shows that, stiffness of the NR increases as the CMC percentage increases.

Maximum value of tensile modulus was recorded for composite with 92 % of NR + 8% of CMC and 0.05 % of Si (i. e. 8.8 MPa) and minimum value was recorded for pure natural rubber (i. e. 0.3 MPa).
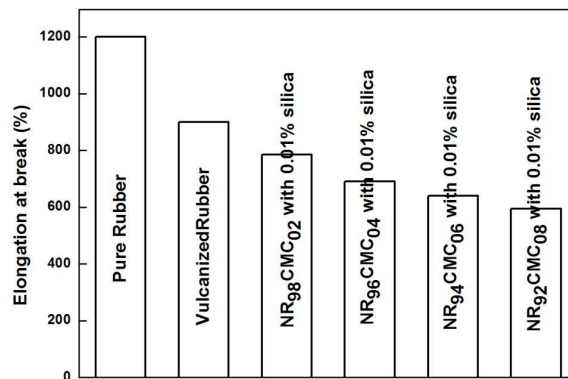
**Figure 3 Variation of Elongation at Break with the
Addition of CMC and Reinforcement of Nano-Silica.**

It is known to all of us that natural rubber exhibits the good elongation property rather than all other material available on the earth. The same is exhibited in the figure 3, it depicts the variation in the elongation at break for the composites discussed in the previous section.

Percentage of elongation recorded for this composite was 59.5%. In addition, it was observed that, percentage of elongation was found to be decreasing for the addition of CMC to the NR in the composites prepared.
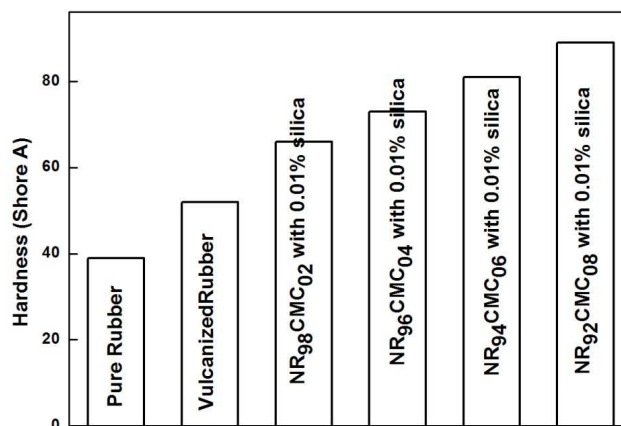

**Figure 4 Variation of Surface Hardness with the
Addition of CMC and Reinforcement of Nano-Silica.**

Figure 4 depicts the surface hardness values for the different composites prepared in the present work. From the above Figure, it was concluded that, hardness property of the composites with 8% of CMC and 0.05 % of Si in NR is higher than the other composites, which are having lesser amount of CMC and higher percentage of NR.

Maximum value of hardness value was obtained is 89 for 92 % NR + 8% CMC + 0.05% Si and least value recorded is 39 for pure natural rubber.
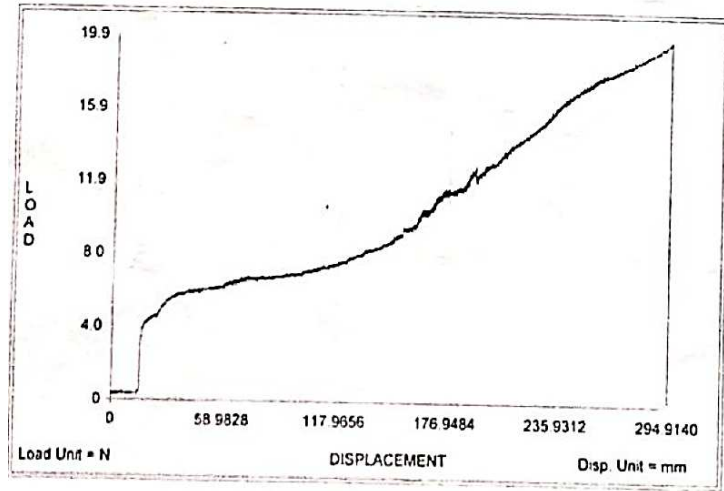
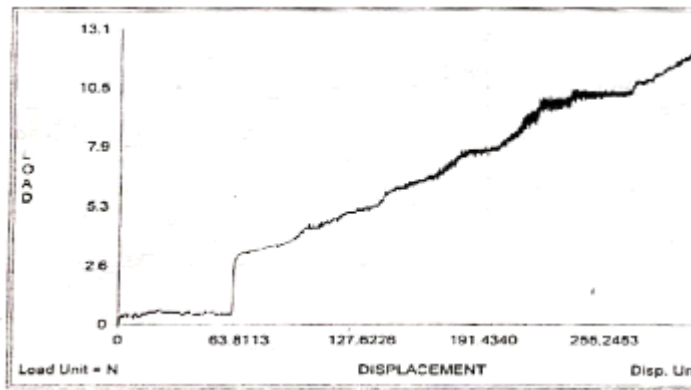**Figure 5: Load V/S Displacement Graph for NR 95 + CMC 05 + 0.05% SILICA + 5 ml GA Material.**

Figure 6: Load V/S Displacement Graph for NR 96 + CMC 04 + 0.05% SILICA + 5 ml GA Material.
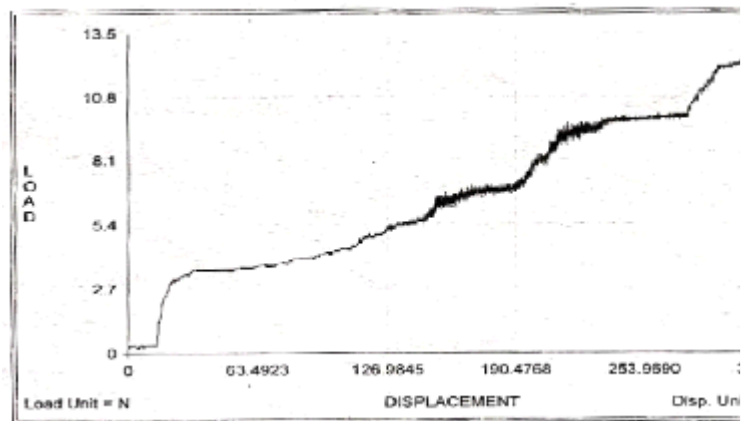

Figure 7: Load V/S Displacement Graph for NR 97 + CMC 03 + 0.05% SILICA + 5 ml GA Material.
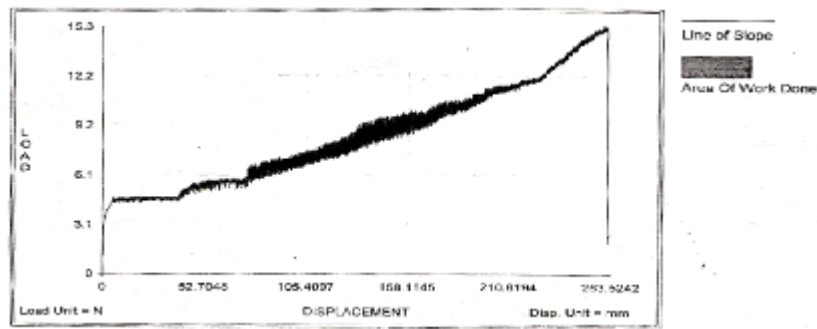
**Figure 8: Load v/s Displacement Graph for NR 98 + CMC 02 + 0.05%
SILICA + 5 ml GA Material.**

Figures 5 to Figure 8 explains about the load v/s displacement characteristics obtained for different combinations of NR and CMC (such as NR with 95, 96, 97 and 98 % and CMC with 5, 4, 3 and 2%) also along with 0.05% Silica and 5 ml of GA for all combinations of NR and CMC.

From these Figures it was observed that, as the CMC percentage increases from Figure 2 to Figure 5 the variations in the load and displacements were diminishes in nature. This is because of flexibility acquired by the composite as the percentage of NR increases and CMC decreases. Increase in the CMC percentage will help in proper and linear load sharing among the Nano particles of silica, GA and CMC. If CMC percentage decreases, it may affect the load sharing property in the composites (Load variations could be seen in Figure 5 to Figure 8. The width of the curve in the middle portion shows the lot of variation or deviation as the load increases and as the percentage of NR increases).

CONCLUSIONS

Natural rubber based Nano-composites have been successfully developed with excellent physical properties. Interpenetrating polymer network of natural rubber and carboxymethyl cellulose has been used as the matrix for the preparation of composite. Glutaraldehyde plays the role to crosslink both the constituent polymer phases simultaneously. Plasticity of natural rubber increases upon the addition of cellulose by reducing its elasticity. Incorporation of Nano-silica as a filler in the IPN matrix improved the stability of rubber. A considerable enhancement in physical properties can be seen by the addition of 0.05% of Nano particles. Tensile strength, tensile modulus and surface hardness of all the composite materials are increased when compared to pristine natural rubber. Interaction between polymer chains and Nano particle leads to increase the stability of the resulting composite materials.

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