Jour. Myan. Acad. Arts & Sc. 2008 **Vol. VI. No. 1**

Performance Study of the Natural Rubber Composite with Clay Minerals

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Abstract

The preparation, characterization and some applications of natural rubber clay composite have been studied. This study investigated the possibility of natural rubber latex to replace some part of natural clays. In formulation of rubber clay composite from natural rubber latex and various clay minerals, three main steps were involved (i) preparation of latex cream (ii) prevulcanization of latex cream (iii) mixing vulcanized latex compound, with other ingredients. In each step, several parameters have been carefully investigated to optimize the performance of natural rubber clay composite production. The composite products were of better quality and can be considered to be more cost effective.

Key words : *Natural rubber (latex), vulcanization, NR- I, NR-K (C) VI, NR-D (M) VI, NR- B (K) VI and NR-B (F) VI*

Introduction

This research work is concerned with the preparation, characterization and application of a natural rubber clay composite. It is made up by the association of natural rubber latex and various raw clay minerals. Latex originally referred to a milky white substance occurring in certain trees and plants. Natural rubber latex is found in the *Hevea brasiliensis* (rubber) tree and plants. Natural rubber (NR) molecule consists of more than 99 % of cis-1,4-polyisoprene. It is widely cultivated in various warm temperature sub - tropical areas of the world. Latex, either natural or synthesis, is a colloidal dispersion of a polymeric material in a liquid system mostly aqueous in nature (Blackley, 1966). Natural rubber is high – molecular weight polymer of isoprene in which all the isoprene have 1-4 configuration (Billmeyer, 1996). Clay is one of the most widely used non-back filler, kaolin (china clay). Clay is an unexpensive natural mineral and has been an important part of the rubber industry.

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Experimental

Clay minerals used as raw materials for the rubber clay composite were procured from the industrial sites. Kaolin (china clay) from RTTCRP, dolomite (from Monywa) (MSTRD), bentonite (from Kyaukpataung) and bentonite (from Australia). Natural rubber latex utilized in this study was achieved from the *Hevea brasiliensis* tree in Inn Ta Gaw Township, Bago Division. ZnO (Zinc oxide), ZDEC (Zincdiethyl dithiocarbmate), BHT (Butylated hydroxyl tolene) and S (Sulphur) were milled for 48 hrs in the motorized ball mill machine under 2450 rpm (SIRI, 1994). Physicochemical properties of different clay minerals were determined. The raw clay minerals were identified and characterized by XRD and EDXRF. Physicochemical properties of natural rubber latex were determined. Stabilized natural rubber latex in stainless steel tank was stirred and heated to 60°C. Dispersion 40 % of ZnO, ZDEC, S, BHT are added to it. The pH was adjusted to 9-11 using 25 % KOH solution, continuously stirring. The formulation of prevulcanization of natural rubber latex with chloroform. This test was done until the small dry crumbs were formed. Compounded latex 100 g and water 50 g were weighed in the glass plate. The sheet was placed in the oven 60°C for about 24 hours. Prepared unfilled natural rubber latex composite sheet was made.

Materials and Methods

All the chemicals used were of standard grade (BDH). The apparatus employed included aXRD (X ray diffractometery Rigaku. D. Max.220, Japan), a EDXRF (Energy dispersive X-ray fluorescence spectrometer Rigaku, Japan) and Scanning Electron Microscope/ Ion Sputter (JFC-1600) SEM (JOEL JSM-5610, Japan).

In all the investigations, the recommended methods and standard procedures involving both conventional and modern technique were employed (Chandar, 1995).

Results and Discussion

The ingredients used were prepared as chemical materials and raw materials were milled using electric ball mill for particle size. The raw clay materials were re-purified for natural rubber latex of clay composite product. Determination of water content, moisture content, loss on ignition test, particle size and pH value of raw clay samples were performed before composite products. XRD analysis kaolin (china clay) showed that it was the presence of kaolinite and qurtz. In the case of dolomite the minerals contained CaMg (CO_3), $CaCO_3$ and quartz. Bentonite (from Kyaukpataung), bentonite (from Australia), kaolin, montorillonite and quartz. Silicon is one of major constituents in the samples of kaoline (china clay), bentonite (from kyaukpataung clay) and bentonite (from Australia). In the case of dolomite, the major constituent is calcium. These EDXRF analyses are agreement with XRD analyses.

According to the investigation, rubber latex cream usually contained alkalinity (or) ammonia content (0.255 %), total solid content (52.62 %), dry rubber content (54 %) and mechanical stability tester was (329s).

The process of vulcanization is one of the steps in their manufacturing process. The elastomeric latex is employed to produce the goods contain some points of unsaturation. It is these points that vulcanizing agent, either sulphur or zinc oxide, react to form links between polymer molecules within the film matrix. Sulphur is usually used to vulcanize the latex cream. Addition of polysulphides to latex followed by controlled heating for a prolonged period of time gave latex which was usually unchanged from the starting materials. However, when it was dried and gently heated, it had the properties of a normally vulcanized piece of dry rubber. Using sulphur, adding an activator (ZnO) an accelerator (ZEDC) the process could be carried out at 60°C (Mausser, 1987). Dry and wet weight of latex, S, ZnO, ZDEC, BHT and KOH for the formation of rubber latex compound are shown in Table 1.

Chloroform coagulation test for NR latex compound is a simple and rapid means for following changes due to pressure after storage or heat treatment of natural rubber latex cream. Then, the results were numerically rated latex cream only was rated as No.1 and judged as uncured latex compound was not as No.4 and was procured to and advanced stage as shown in Figure 1.

NR-I composite sheet was prepared by natural rubber without filler and composite NR-K (C), NR-D (M), NR-B (K) and NR-B(F) II to VIII were prepared with different percents 5, 10, 15, 20, 25, 30 and 35 % of various clay with 100% of rubber. These prepared composites are shown in Figures 14, 15, 16 and 17.

Figure 1: Tapping of natural rubber latex at the rubber plantations

Figure 2: Natural rubber latex of *Hevea brasiliensis* (rubber)

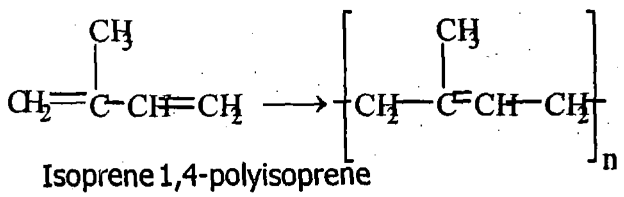


Figure 3: Structure of isoprene and polyisoprene

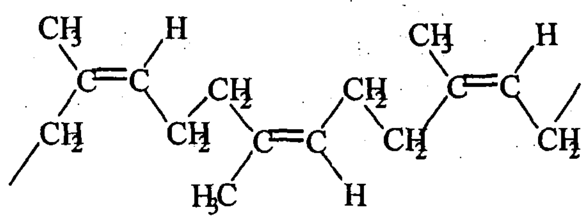


Figure 4: The polymer structure of natural rubber

Determination of total solid content (TSC) in rubber latex
Procedure

Weight two dishes
↓ latex, dry in oven
sample whiteness
↓ cool in desiccator
weight dish I, II

Total solid content: Dish I = 52.62 %
Dish II = 53.61 %

Determination of Mechanical Stability Tester (MST)

Latex + KOH (Stabilizer)

First time 80 + 1 % (Stability time – 5 min 29 s (329 s)

Second 80 + 1 % (stability time – 5 min 3 s (303 s)

Determination of Alkalinity (% of NH_3)

Procedure

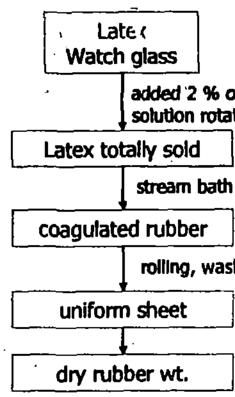
Latex $\xrightarrow[\text{distilled water}]{\text{added}}$ Latex solution $\xrightarrow[\text{Yellow to pint colour}]{\text{0.1 M HCl, indicator (2 methyl red)}}$ HCl (dm^3)

17

Alkalinity (NH_3) = 0.255 %

Determination of Dry Rubber Content (DRC)

Procedure



dry rubber content = 54 %

Preparation of additives precured (%) by 100 % water

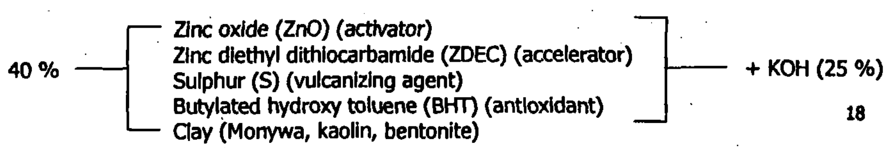


Table 1. Formulation of Rubber Latex Compound and Dry and Wet Weight of Latex

Components	Formulation of rubber latex compound (g)	Dry weight (g)	Wet weight (g)
54 % Latex	100	2371.03	4390.8
40 % S	1	23.71	59.27
40 % ZnO	1.2	28.45	71.12
40 % ZDEC	0.8	18.48	46.2
40 % BHT	1	23.71	59.27
25 % KOH	1	23.71	94.84

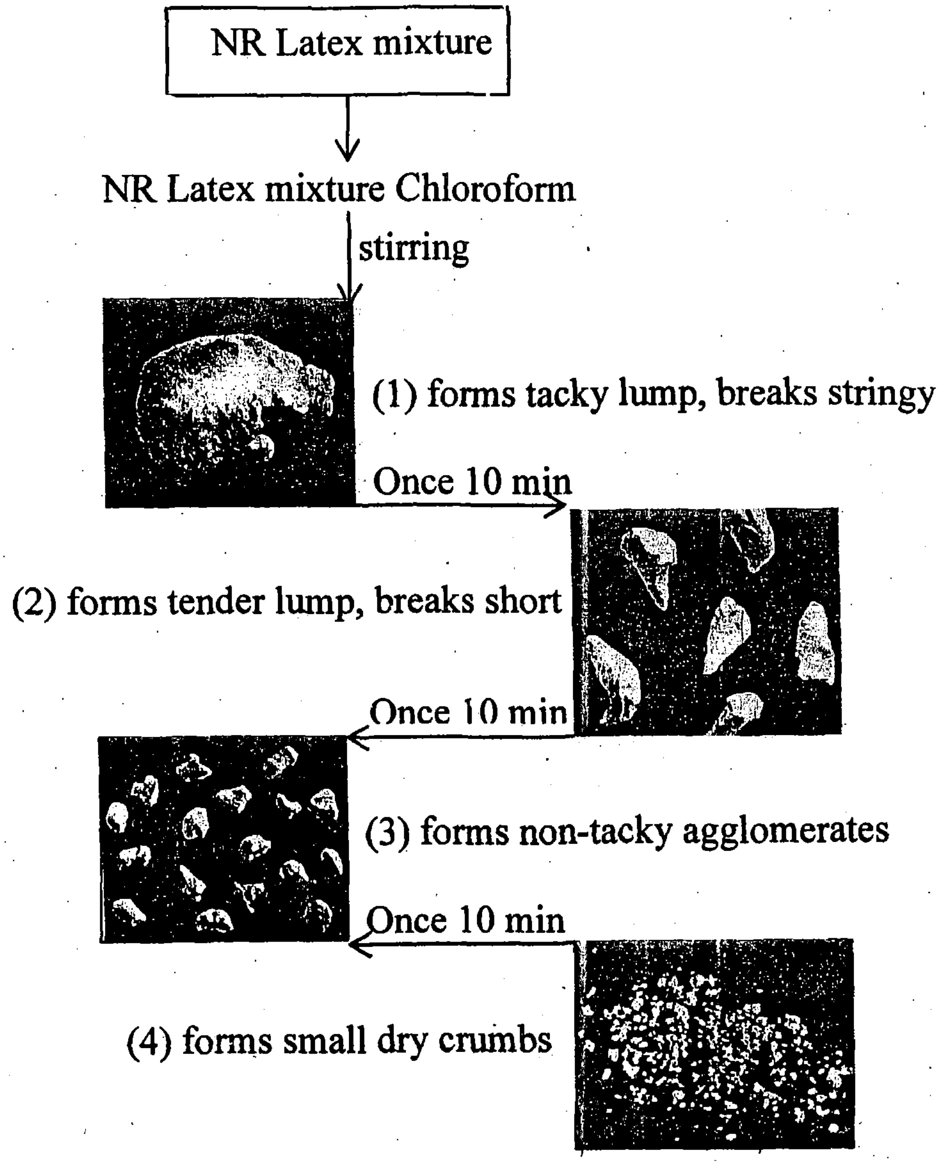


Figure 5. Chloroform coagulation test for nature rubber latex compound

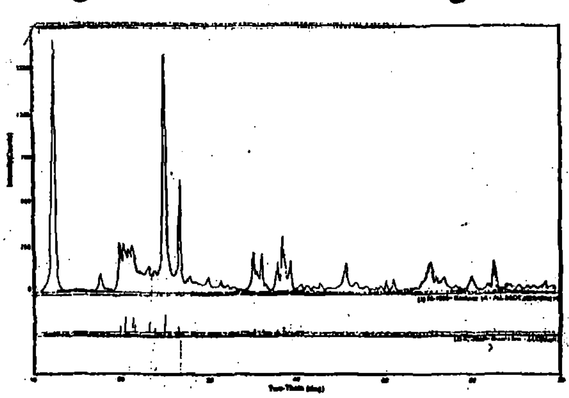


Figure 6. XRD spectrum of Kaolin (China Clay)

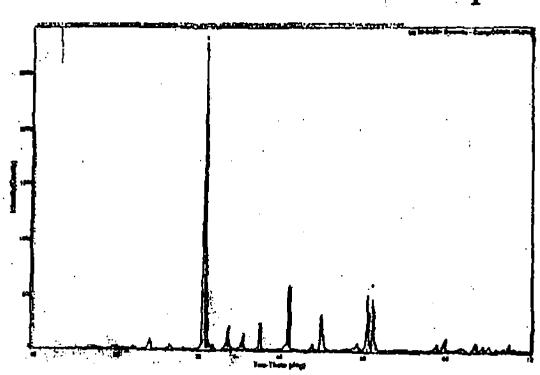


Figure 7. XRD spectrum of Dolomite (from Monywa)

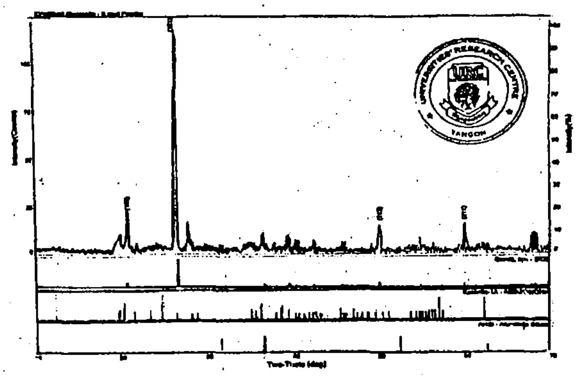


Figure 8. XRD spectrum of Betonite (from Kyaukpataung)

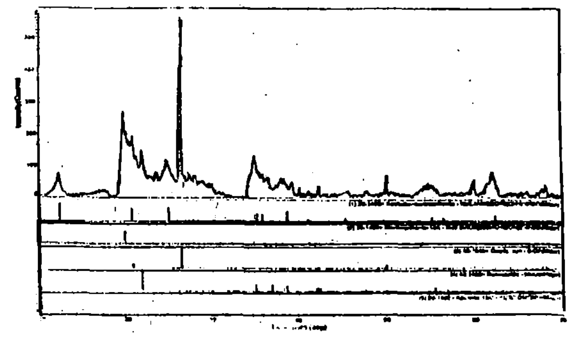


Figure 9. XRD spectrum of Bentonite (from Australia)

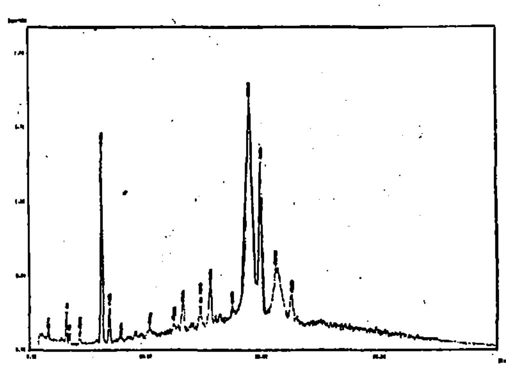


Figure 10. EDXRF spectrum of Kaolin Dolomite (China clay)

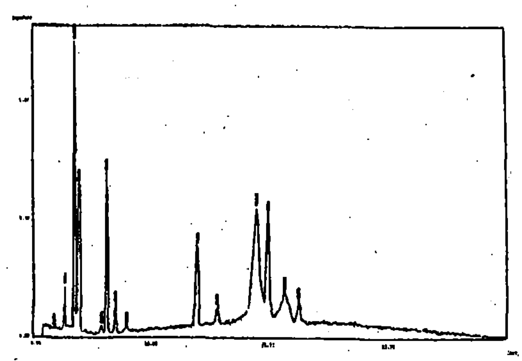


Figure 11. EDXRF spectrum of (from Monywa)

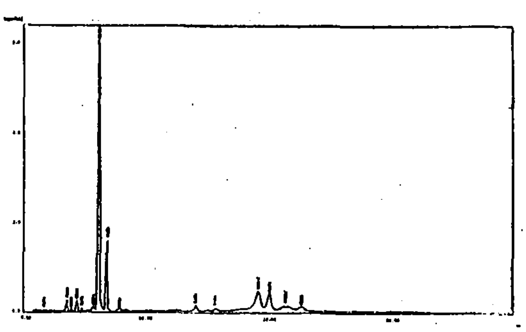


Figure 12. EDXRF spectrum of Bentonite Bentonite (from Kyaukpataung)

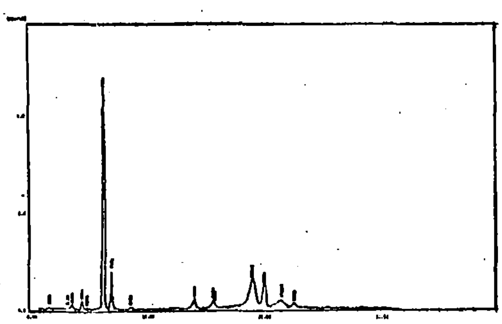


Figure 13. EDXRF spectrum of (from Australia)

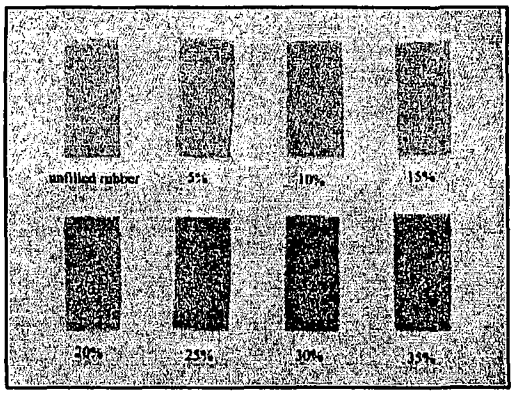


Figure 14. Unfilled natural rubber latex composite sheet and natural rubber latex with Kaolin (China clay) (5 to 35%) composite sheet

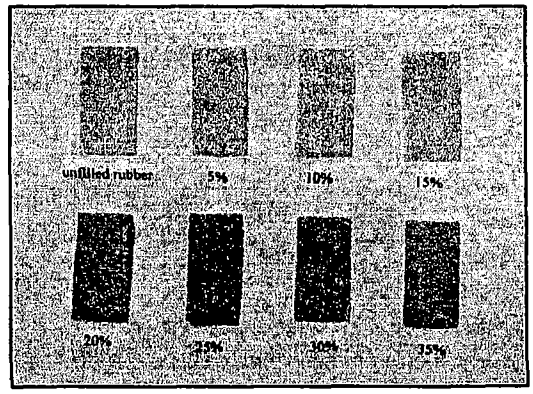


Figure 15. Unfilled natural rubber latex composite sheet and natural rubber latex with Dolomite (from Monywa) (5 to 35%) composite sheet

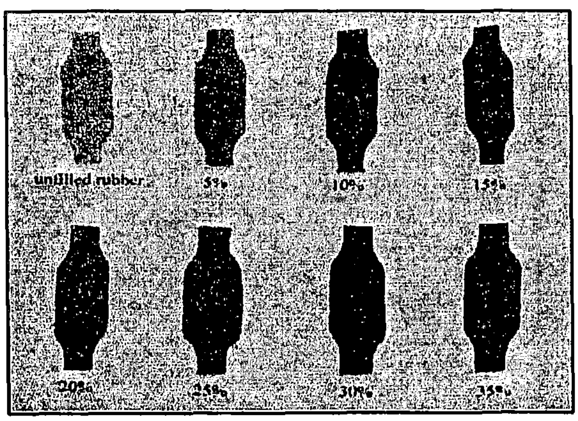


Figure 16. Unfilled natural rubber latex composite sheet and natural rubber latex with Bentonite (from Kyaukpataung) (5 to 35%) composite sheet

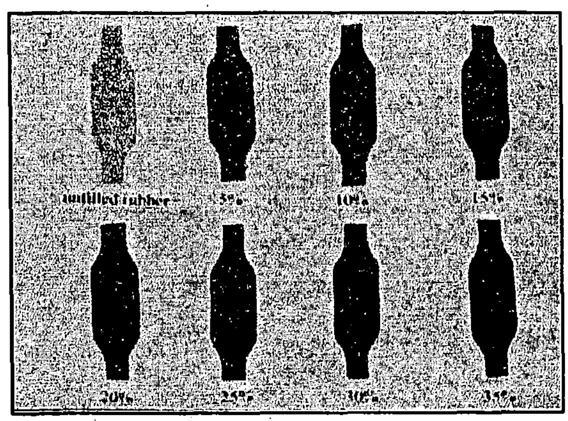


Figure 17. Unfilled natural rubber latex composite sheet and natural rubber latex with Bentonite (from Australia) (5to 35 %) composite sheet

Conclusion

The results of this investigation have shown that a specific selected and speciation of two types of rubber clay composites can be successfully prepared from a renewable resource like natural rubber latex. From the overall assessment of the results obtained, it was found that rubber-clay composites could be derived from rubber latex with kaolin (China clay), dolomite from Monywa, bentonite from Kyaukpataung and bentonite from Australia as fillers.

The composition of the weight percent range of clay (5 to 35 %) to rubber latex (100 %) was feasible to produce durable rubber-clay composite sheets product. The composite products were of better quality and can be considered to be more cost effective.

Acknowledgement

The author would like to thank the Department of Higher Education, Yangon, Myanmar and to Professor / Head Dr. Saw Hla Myint, Department of Chemistry, Yangon University for allowing to carry out this research programme. Profound gratitude is specially expressed to supervisors Emeritus Prof. Dr. Nyunt Wynn, Associate Professor, Dr. Kyaw Myo Naing and Dr. Tin Tin Aye, Department of Chemistry, University of Yangon.

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