EFFECTS OF CHEMICAL TREATMENT ON THE FILLER PROPERTIES OF RICE HUSK

Ayo M. D.
Auchi Polytechnic, Auchi, Edo State, Nigeria
E-mail address: dadaayo2335@gmail.com

Tenebe O. G.
Department of Polymer Technology,
Nigeria Institute of Leather and Science Technology, Zaria, Nigeria

Amoke A.
Auchi Polytechnic, Auchi, Edo State, Nigeria

Edegbe O. C.
Auchi Polytechnic, Auchi, Edo State, Nigeria

ABSTRACT
The research is on the effects of chemical treatment on the filler properties of rice husk powder. Rice husks were obtained from the mill and shared into four parts. One part is untreated and the remaining parts were treated in 10% sodium hydroxide, 10% benzoyl chloride and 10% hydrogen peroxide. The four different samples were ground and filtered and then characterized in terms of moisture absorption, lignin content, hemicellulose content and cellulose content. The FTIR and SEM analysis were carried out to know the functional group and the structure of the samples. The results showed that the moisture absorption decreased for the treated samples while the cellulose content increased. The SEM micrograph showed a finer structure for the treated samples. This may suggest stronger reinforcement for the treated samples.

Keywords: Additives, Chemical, Husk, Powder, Treatment

INTRODUCTION
Product modification has become a current trend in the utilization of modern materials especially in achieving better vulcanizate properties as applied to rubber compounding. Prominent additives for rubber products modification are wide range of filler materials for which carbon black has often taken the lead when it comes to the use of filler for improvement in reinforcement properties. Carbon black has its short coming such as its non-renewable petroleum origin, dark colour, the health challenges in the use of carbon black with its high nitrosamines contents in rubber compounding have become worrisome in the recent times (Agunsoye, Olumuyiwa & Isaac, 2012). Today in Nigeria, there are lots of research going on to find an alternative (local source) for carbon black. Advances are being made into the use of agricultural by-products such as groundnut shell, coconut fibre, pineapple leaves, rubber seed shell etc; as filler in rubber compounding.
The Nigerian Federal Government Policy on rice production has led to high volume of rice been produced in the country. Consequently, rice husk will reach up to 25% of the total waste, consisting mainly of lignocellulosic materials. Rice husk waste is a potential candidate for the development of new composites. Rice husk filler like all other natural fillers suffer certain disadvantages which the present work sought to correct and improve upon.

EXPERIMENTAL
Rice husk used in this study were obtained from a rice milling machine in Auchi, Edo State, Nigeria. Sodium hydroxide, benzoyl chloride, hydrogen peroxide were obtained from Titan Biotech Ltd, India. These materials were used as received.

SAMPLE PREPARATION

Rice husk from the milling engine were obtained and divided into four parts. One part was treated with 10% sodium hydroxide solution for one hour at room temperature. The solution was then filtered and the residue was thoroughly washed with distilled water, dried at room temperature for 48 hours followed with oven drying at 70^0C for 2 hours.

The second and third parts were separately treated with 10% benzoyl chloride and hydrogen peroxide separately, filtered and the various residues were washed with distilled water and air dried at room temperature for 48 hours and then oven dried at 70^0C for 2 hours.

The fourth part was not treated. The various treated rice husk and the untreated rice husk were ground and filtered with a sieve of mesh 75µm.

CHARACTERISTICS OF THE FILLER

The fillers were characterized in terms of moisture absorption, chemical composition (lignin content, hemicellulose content and cellulose content) and the morphological structure using scanning electron microscope.

The lignin content of the untreated and treated samples were determined using ASTMD 106-56 (1977) method. The hemicellulose content was determined using ASTMD 1104-56 (1978) method. The cellulose content was determined using ASTMD 1103-60 (1978). The moisture absorptions of relative humidity of 60^0C were determined using the method described by Wang (2004). The Fourier Transform Infrared of the powdered samples were carried out using the Fourier's Transform Infrared Spectrometer Nicolet ISIO FTIR spectrometer and the morphology of the powdered samples were carried out using Scanning Electron Microscope, Joel-JSM 7600 F(1)

Table 1: Characteristics of the Powdered Filler

Properties	Untreated sample	Mercerized sample	Benzoylated sample	Hydrogen peroxide sample
Moisture absorption (%)	8.85	5.15	4.86	5.10
Lignin content (%)	18.42	10.24	8.26	9.35
Hemicellulose content (%)	20.35	18.00	14.25	15.36
Cellulose content (%)	32.86	36.00	40.10	38.95

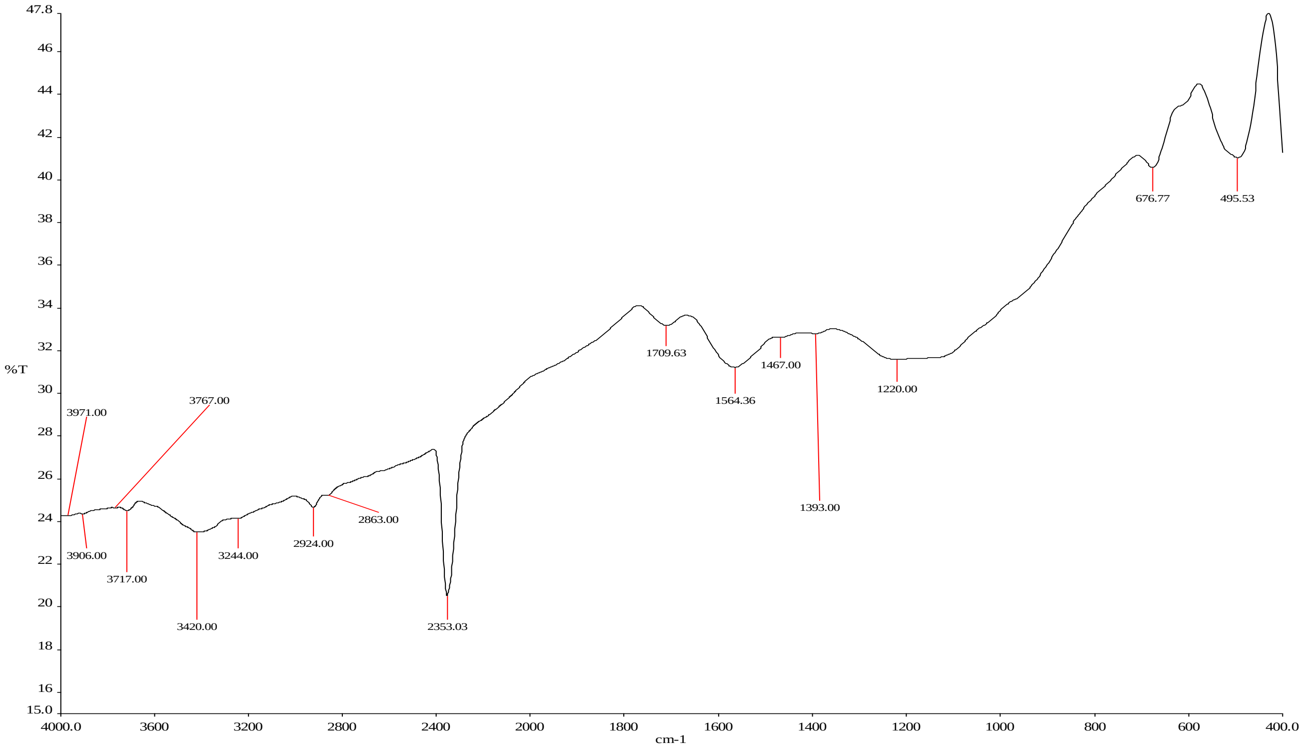

Figure 1: FTIR of the untreated Rice Husk Powder

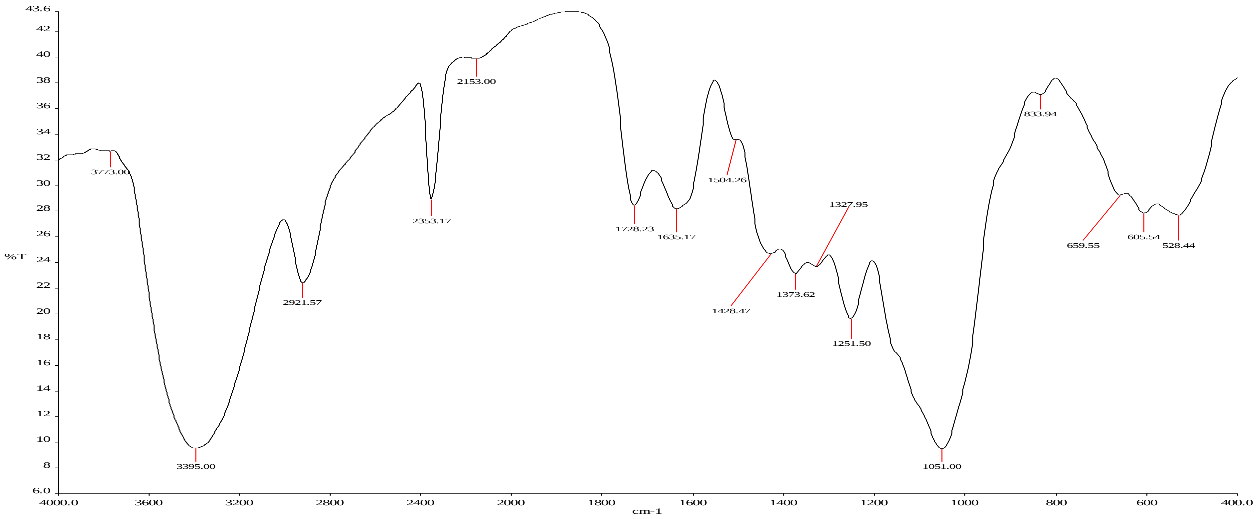

Figure 2: FTIR of the Mercerized treated Rice husk Powder

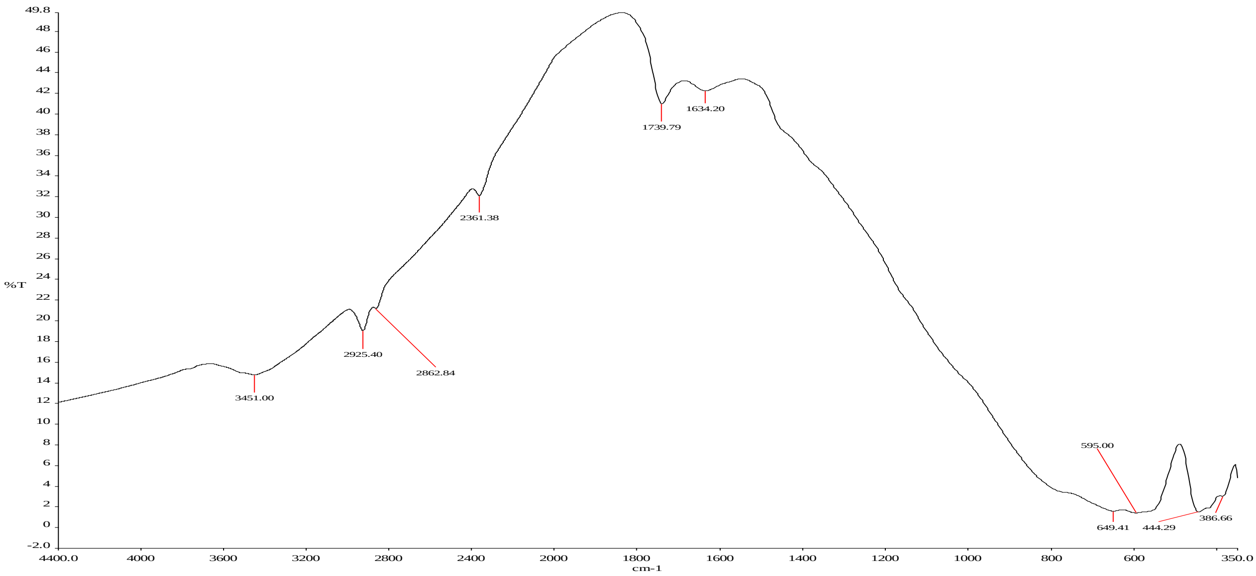

Figure 3: FTIR of the Benzoyl chloride treated Rice husk Powder

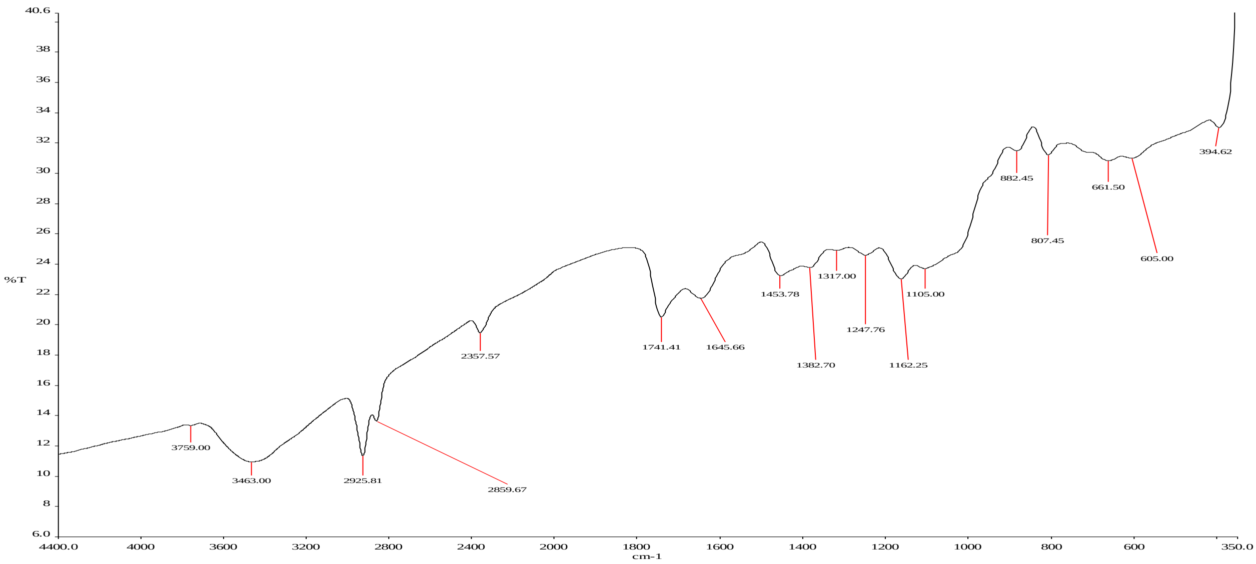

Figure 4: FTIR of the Hydrogen peroxide treated Rice husk Powder

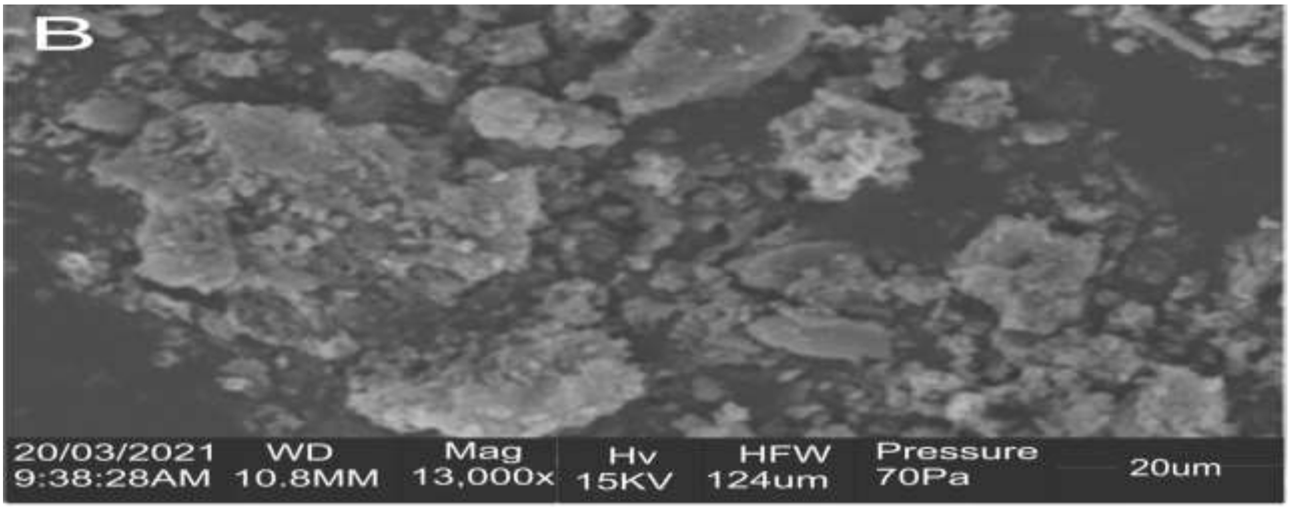

Figure 5: SEM Micrograph of the Benzoyl chloride treated Rice husk Powder

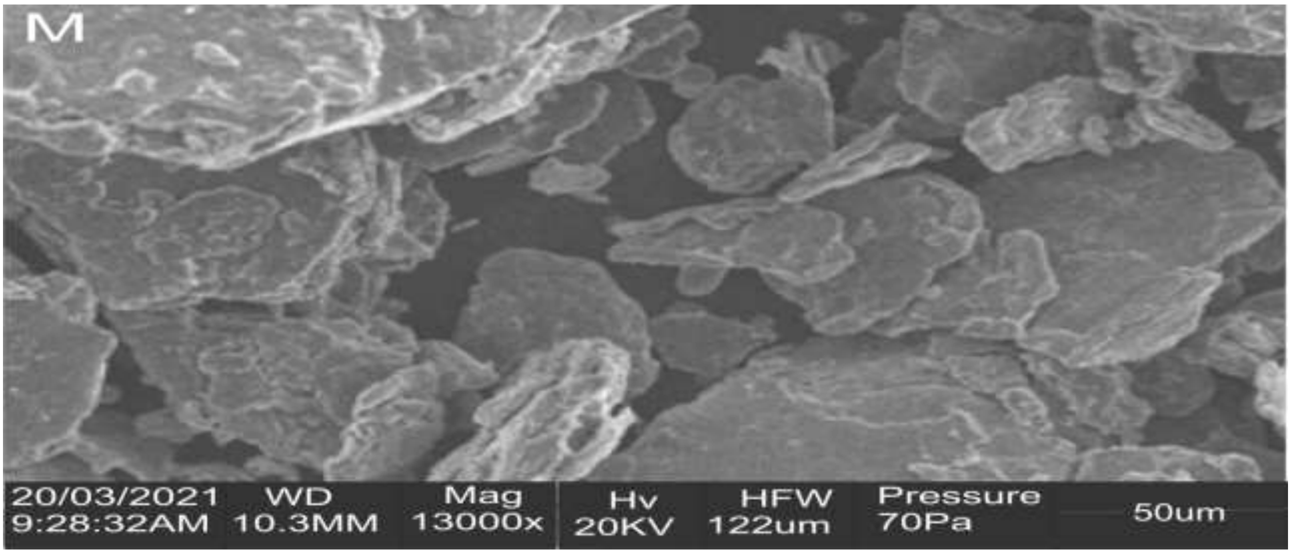

Figure 6: SEM Micrograph of the Mercerized treated Rice husk Powder

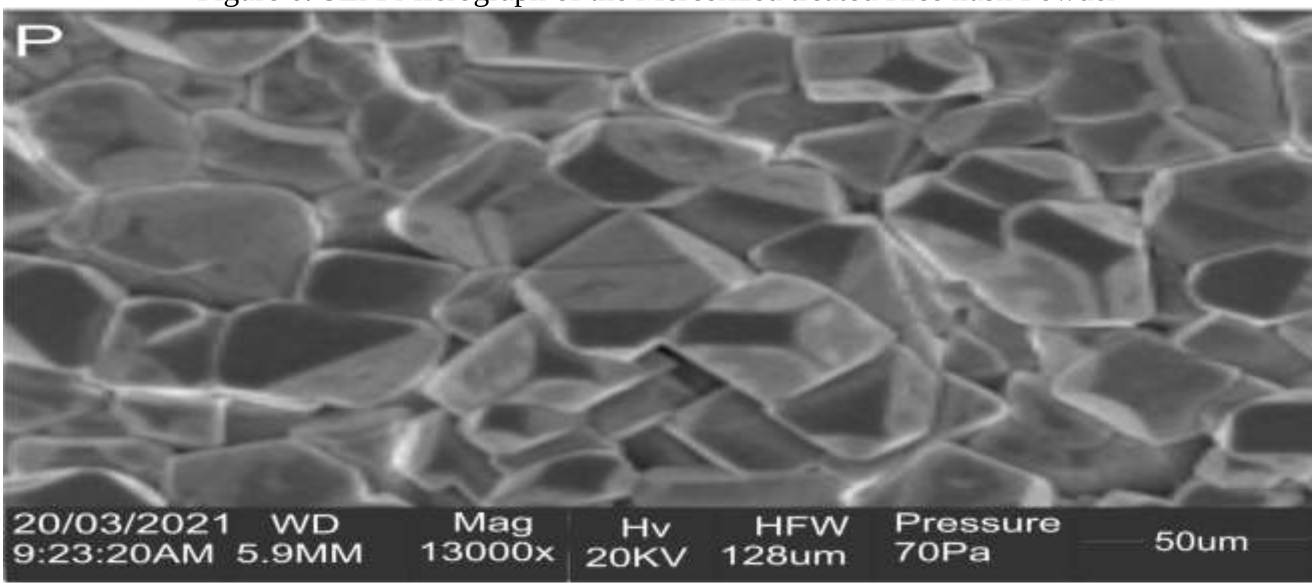

Figure 7: SEM of the Hydrogen peroxide treated Rice husk Powder

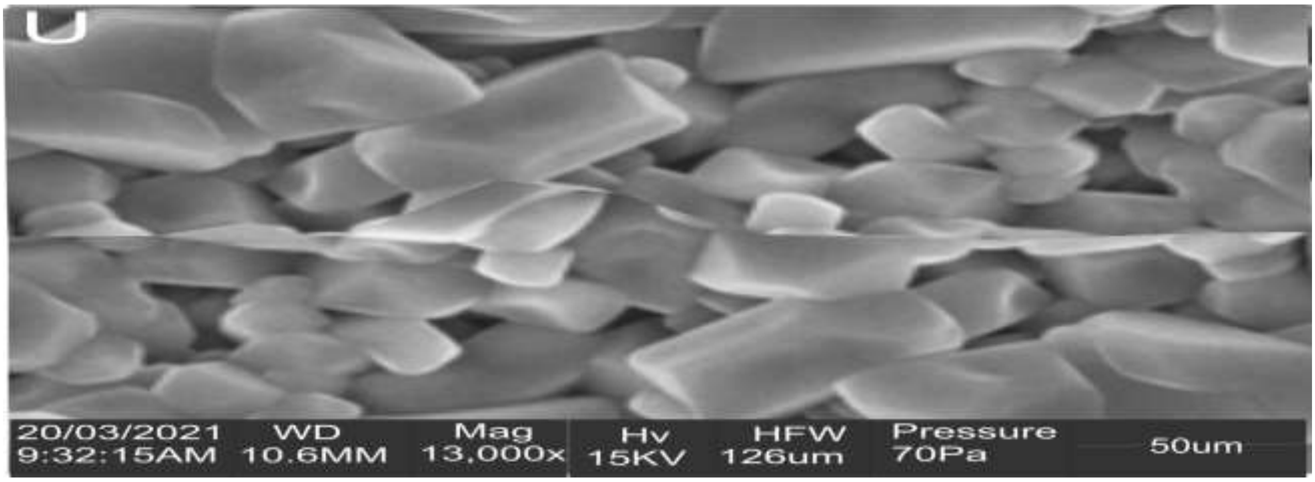

Figure 8: SEM Micrograph of the untreated Rice husk Powder

The result of the characteristics samples are presented in Table 1 above; there was decrease in the moisture absorption for the treated samples. Reduction of about 50% moisture uptake for acetylated jute fibres has been reported by Bledzki and Gassan (1999).

The result of the chemical constituents showed a progressive decrease on percentage of lignin and hemicellulose while there was a significant increase in percent of the cellulose content. This is expected because more lignin and hemicellulose are gradually removed as a result of the chemical treatment thereby increasing the yield of cellulose in the fibre.

The chemical structure of the untreated rice husk powder and the chemically treated rice husk powder are shown in Figure 1-4. The FTIR spectra of untreated rice husk powder show a characteristic carbonyl absorption peak at 1709.63cm^{-1}. This was attributed to the acetyl and uronic ester groups of the hemicellulose (Kamel, 2007). The peak at 1564.36cm^{-1} show the aromatic C=C stretch of the aromatic rings of the lignin (Donescu et al, 2008, Laka and Chemyavskaya, 2007).

The FTIR spectra of the mercerized rice husk powder shows the removal of lignin resulting in the reduction of the characteristic band at 1564cm^{-1} to 1504.26cm^{-1}.

The FTIR spectra of the benzoylated treatment and hydrogen peroxide treatment show the complete removal of lignin resulting in the varnishing characteristic band at 1564.36cm^{-1}.

The spectra for the 10% NaOH, 10% benzoyl chloride and 10% hydrogen peroxide show that the treatment of the rice husk have changed the functional groups onto the surface of absorbent.

The results of the scanning electron microscopy analysis of the untreated and treated rice husk powder are presented in Figure 5-8.

The SEM provided microstructural evidence of characteristic cellular morphologies of pore cells as the modification process proceeds. It could be seen that as chemical modification changes from benzoylated to mercerized to hydrogen peroxide, the surface of the filler gets finer and cleaner than the untreated filler.

The SEM micrographs revealed that the interfacial bonding between treated elements and filler matrix was significant suggesting that further evaluation of filler on composites should be verified for possible reinforcement along the benzoylated to mercerized to hydrogen peroxide.

The optical clarity in untreated rice husk powder showed no interlinks of added elements of modification. Added elements of modification altar the clarity of filler given indication of dark patches of modification.

Presence of tiny particles orifices showed indication of additional elements bonding pores and cells together. This is an indication of regular arrangement, properly aligned morphologies and structure which could have resulted from modification.

There was an indication of better interfacial interactions as modification proceeds from benzoylated to mercerized to hydrogen peroxide. Further evaluations are suggested for indicative strength improvement via reinforcement.

Obviously, large agglomerations of particles as seen in untreated rice husk powder may suggest weaker reinforcement while tiny/fine agglomerates may suggest stronger reinforcement if further probing of physical-mechanical indices are verified.

CONCLUSION

The work is an attempt at exploring the effects of chemical treatment on the filler properties of rice husk powder. The results showed that chemical treatment affect the filler properties. These results predict the potential application of the filler.

ACKNOWLEDGEMENT

We are grateful to Tertiary Education Trust Fund (TETFUND) for the financial assistance and support to undertake this research work. We equally thank management of Auchi Polytechnic, Auchi, Edo State, Nigeria for their contributions in this research work.

REFERENCES

1) Agunsoye, J; Olumuyiwa, T.S; & Isaac, S.O.S (2012): Study of Mechanical Behaviour of Coconut Shell Reinforced Polymer Matrix Composites. Journal of Minerals and Minerals Characterization and Engineering 4(2): 774-779.
2) ASTM-D 11o6-56 (1977): America Standard Testing Method for Lignin
3) ASTM-D 1104-56 (1978): American Standard Testing Method for Hemicellulose Content.
4) ASTM-D 1103-60 (1978): America Standard Testing Method for Cellulose Content.
5) Bledzki, A.K; & Gassan, J. (1999): Composites Reinforced with Cellulose based Fibres, Journal of Progress in Polymer Science 24(2): 221-274.
6) Kamel, J (2007): Nanotechnology and its Application in Lignocellulosic Composites, a mini review, Express Polymer Letters 1(9): 546-575.
7) Laka, J.M & Chemyavskaya, S (2007): Obtaining Crystalline Cellulose from Softwood and Hardwood Pulp. Bio Resources 2(3): 583-589.
8) Wang, B (2004): Pretreatment of Flax Fibres for use in Rotational Moulded Biocomposites, M.Sc Thesis, University of Saskatchewan.