SYNTHESIS AND CHARACTERIZATION OF CHEMICALLY TREATED FIBRE AND ITS REINFORCED EPOXY POLYMER COMPOSITES

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Abstract: The main objective of this paper is to study the mechanical and electrical performance of synthesized polymer composites by reinforcement with coir fibre. It has been investigated that the mode of making of the composites shows a lot of valuable influences on the product. The chemical treatment and firing produced a unique kind of composite and is revealed from its characterization first by Scanning Electron Microscope (SEM) and thereafter by electrical responses including a.c. conductivity. We have found out that the fibre performs spongy / foamy structure and are very soft and hence can be easily powdered. Finally, when it is embedded with resin, hardener and treated fibre, the composite, it is produce to be hardened. There is a need to have better homogeneity by modification in the making process.

Keywords: a.c. conductivity, frequency dependence of conductivity, temperature dependence of dielectric constant, reinforcement, polymer composites.

1.Introduction: The technology in recent years has grown in all aspect of life so rapidly that to keep a track of it is impossible to any investigator. In this competitive world, revolution is seen in every aspect of science and technology useable material. Our present study namely making different sample composites with polymers may also be a step forward in enriching the experiences. In this paper we describe making of unique samples with extraordinary quality which might find interest in case their characterization proves to be useful. The growing demand of polymer composite has inspired researchers to explore this new area.

In the present study, we explore relevance and making of epoxy–coir fibre polymer composites and undertake to find their electrical properties. Composite is an intricate mix of two or more materials. The performance characteristic of which has to differ from its individual components [1]. The purpose of making the composites is to make the new material to have its mechanical strength improved. Most of the composites have minimum of two constituent materials (the constituent unit being a stoichiometric chemical compound): i) a binder or matrix and ii) reinforcing component. The reinforced composite is usually much stronger and stiffer than the matrix. The matrix holds the reinforcement compound in an orderly pattern. But if the reinforcement is discontinuous, the matrix needs to have filler which acts and takes up the load within the reinforcement. Some common composite materials are reinforced cement concrete (RCC), fibre glass, mud bricks embedded with rice husk, and natural composites such as rock & wood [1]-[2]. It may be noted that composites are not alloys or any other kind of admixture. Composites are different from alloys because alloys are mixture of elements and so homogenized that it is impossible to distinguish one particle from the other.

Natural fibres are also considered as natural component of composites consisting of cellulose fibrils, embedded in lignin matrix. And have the properties such as low density, low cost, non-toxic, high specific strength, environmental friendliness, etc. The natural fibre reinforced polymer composites give this class of material an advantage over synthetic fibres reinforced composites such as glass fibre reinforced composites [3]-[6]. There are several plant based of natural fibres, such as kenaf, jute, sisal, cotton, etc., which are being tried for reinforcement with polymers and cement [7]-[9].

Natural lingo-cellulosic fibres have recently attracted the attention of scientists because these are low cost fibres with low density, high specific properties and are biodegradable in nature. However, certain drawbacks such as incompatibility with the hydrophobic polymers, the tendency to form aggregate during processing and poor resistance to moisture greatly reduce the potential use of natural fibres. Natural fibres are grouped into three types a) seed fibre b) best/weed/wood fibres and c) leaf fibres, depending upon the source. Some examples are cotton (seed hairs), ramie, jute, flax (best fibres), and sisal and abaca (leaf fibres). Of these fibres, jute, ramie, flax, and sisal are most commonly used fibres for polymer composites. The chemical compositions of natural fibres vary depending upon the type of fibre. Cellulosic fibres are hydrophilic and absorb moisture [10]. The moisture content of the fibres can vary between 5% and 10%. This can lead to dimensional variations in composites and also affects the electrical and mechanical properties of the composites. During processing of composites based on thermoplastics, the moisture content can lead to poor processing and defective products [10].

Epoxy resins are important thermo-sets with many engineering applications. In the present investigation, composites have been developed using coir fibre to ensure improved properties of epoxy composites. The uses of coir fibre as reinforcement are to use otherwise a waste product. Further the composites are being investigated for electrical and morphological behavior. Some interesting results are reported here.

2.Method of Materials Processing of Coir Fibre Composites: The fibre used for the experimental studies was taken from dry coconut skull. The fibre was kept dipped in water for 24 hours and then washed away. After drying it at room temperature chemical treatment was given to it.

A. Chemical Treatment of Fibre

Ferric nitrate and ammonium chloride salts are used for the chemical treatment of fibre. The coir fibre used contains 42.44% of cellulose, 45.4% legnin, 0.25% of cellulose, 3% pectin and other constituents. To treat it we take aluminum nitrate and ammonium chloride in the ratio 10:4 in 500 ml of distilled water. A 100 g of fibre was submerged into the solution and then 100 drops of ammonia is poured to it and left it for one hour. Again the mixed is dried and then fired it in a muffle furnace at 1000^0C and kept it at that temperature for 15 min.

B. Nature and Structure of Fibre

The material is found to be corrosive/foamy and with holes in appearance. Its microscopic view has been shown in Fig. 1 (a and b) by using different magnification mode.

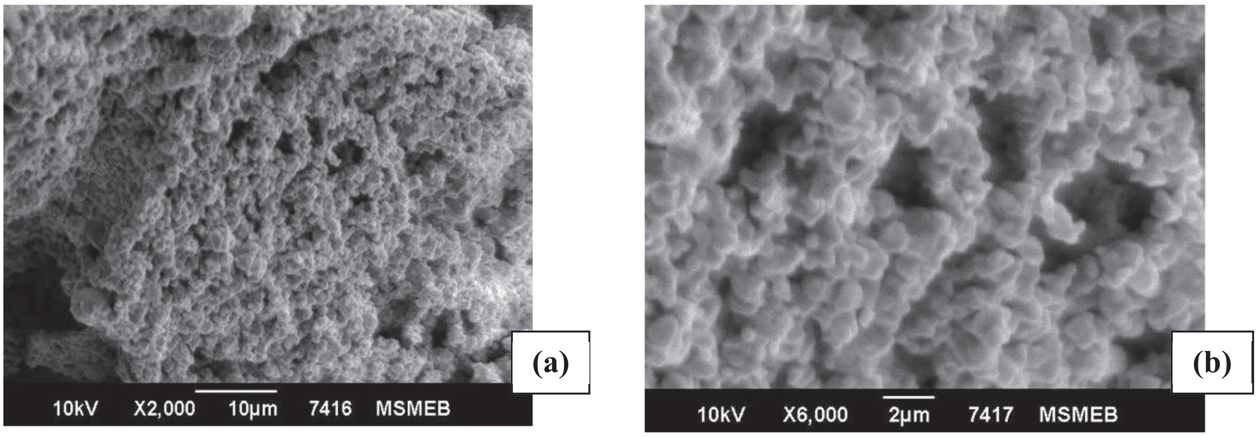

Fig. 1: Scanned Electron Microscopy (SEM) view of chemically treated fibre (a) Normal (b) About 4 times magnified

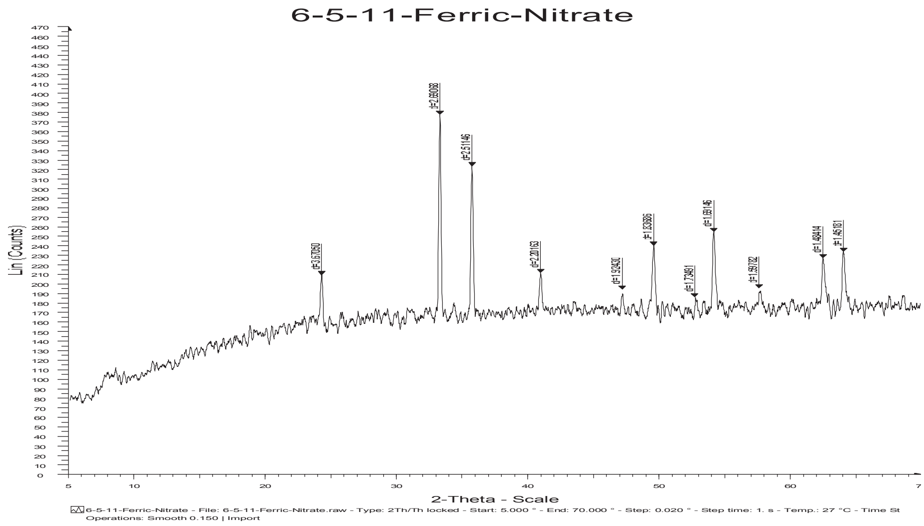

Fig. 2: XRD analysis of chemically treated fibre. In this figure Lin (counts) is shown on Y axis and 2-Theta – Scale on X axis as it is used in XRD analysis pattern.

On behalf of the pictorial view in Fig. 1 (a and b), one can catch that the chemically treated fibre under microscope appears to be (i) Homogeneous, (ii) Spongy like and (iii) having several cylindrical cavities.

But it does not physically show its spongy nature; instead it is soft but not spongy. Even a blow or a gentle force makes it break the structure. Thus it can be converted into fine rust like powder on grinding. Thus if it can be hardened a little it can act as thermocol.

C. XRD Analysis of Treated Fibre

Futher more we have studied the Xrd analysis of treated fibre and is depicted in Fig. 2. The resuls have been compared with Xrd results for composites $Fe_2O_3.Fe_3O_4.FeO$ [11]. So, we can claim the all peaks prominent in our sample have corrosponding peaks (though of considerably low intensity) in $Fe_2O_3.Fe_3O_4.FeO$ composite.

But there is reponderence for planes ≈ 2.5 apart. However our samples show quite large intense backgrounding diffraction. Thus the following inferences can be drawn (for which configration would be verified in XRD) of our samples:

1.) there is definite crystalline phase of Fe_2O_3.

2.) the composite is highly amorphous.

3.) crystalline Fe_2O_3 is in some fraction separated from $Fe(NO_3)$ on treatment of the sample which is mostly amorphous.

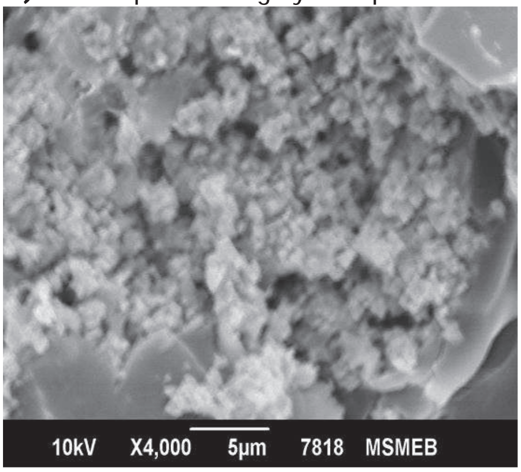

Fig. 3: A Scanning Electron Microscopy (SEM) view of the epoxy- fibre reinforced polymer composite.

3. Preparation of Polymer Composites: The treated fibre was then mixed with epoxy in ratio 1:1:1 (resin : hardener : treated fibre). It was done in following sequences: i) the resin is mixed with treated fibre and allowed to stand with constant stirring for 15 minutes so that proper mixing can be ensured. ii) Then it was mixed with hardener and allowed it to set for 12 hours. iii) Lastly, the pallets were made for further study.

The scanning electron microscopy was done on the polymer composite to analyze it. A pictorial view of epoxy fibre reinforced polymer has been shown in Fig. 3 by using SEM. In this picture, the homogeneity is lost. The composite appears segregated into distinct phases. However, the hardness appears on physical observation.

4. Results and discussions: Finally, we have studied the electrical properties with the help of Wayne Kerr impedance analyzer. The conductivity can be calculated by using the formulas as:

$$\varepsilon' = \frac{c}{c_0} \quad (1)$$

$$\sigma_{ac} = \varepsilon_0 \omega \epsilon' \tan\delta \quad (2)$$

where symbols represent their usual conventional value. Other properties of the composite have been discussed at length elsewhere.

The composite was observed for its capacitative behavior and dissipative factor at different temperatures above from 300 °C and also at different frequencies as tabulated in the Table-I.

Table-I: Capacitive behavior and dissipation factor of the composite at frequency 1000 Hz and 500 Hz at different temperatures.

S.No.	Temperature (°C)	Frequency at 1000 Hz		Frequency at 500 Hz	
		Capacitance (pF)	tanδ (au)	Capacitance (pF)	tanδ (au)
1	30	6.104	7.157	4.758	2.086
2	35	5.270	1.857	4.497	0.397
3	40	4.867	0.165	4.364	0.105
4	45	5.225	0.168	4.733	0.102
5	50	6.525	0.275	5.714	0.181
6	55	7.771	0.448	6.659	0.256
7	60	9.310	0.725	7.724	0.364

5. Summary and Conclusions: A detail study has been done for characterization of the composite varying the two parameters independently viz. temperature and frequency and its dependence on capacitive behavior and dissipation factor.

So based on the present experimental work, one can draw some salient conclusions as:

(i) The capacitance as well as the loss factor is first found to decrease with rise in temperature up to 40°C and then the values of capacitance are slightly increased where as the values tanδ are arbitrary for both the frequencies.

(ii) There is an optimum value of temperature for their electrical responses. The cause of it may be searched out.

(iii) Since these are only representative values, the observations which are numerous (with us) show a similar trend as reported by various experiments / authors.

(iv) Frequency change only causes the numerical value of those factors and not the nature.

(v) On mixing in epoxy resin and treated produce inhomogeniety but possess hardness.

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