Processing and properties of Bio-waste reinforced polymer composites

Harinath Aireddy and S.C.Mishra

Metallurgical and materials Engineering Dept.

National Institute of Technology,Rourkela.

INDIA

Corresponding author: subash.mishra@gmail.com

Fax: +91-661-2462999

Abstract

Polymer composite was prepared by hand lay out method using epoxy resin as the matrix and coir dust as the reinforcement. Composites of four different compositions (amount of reinforcements) are made. The density, void fraction, hardness, flexural strength, and the dielectric constant of the composites were evaluated. It was found that , the flexural strength and hardness are decreases with increasing the amount of reinforcement due to the increment in the void fraction and softness of the reinforcement material. The density decreases with increasing reinforcement content. The void fraction shows that increasing trend with increase reinforcement amount and the dielectric constant of the composite material varies from 6.29 to 11.84 with the composition.

Key Words: polymer composite , void fraction , hardness , dielectric loss , polarization.

Introduction

Natural fibers have proven to be suitable reinforcement materials for composite gives to a combination of mechanical properties and environmental advantages such as renewability and biodegrabilite [1-3]. Hence for these reason we can observe the use of natural materials in the production of composites has gained significant importance in automotive industry, as well as the packing industry for applications where strength is not issue[4-5].These materials are also important to the electronic industry for its dielectric properties in the use of capacitors[6-8].Interestingly, several types of natural fibers which are abundantly available like jute, sisal, banana, bamboo, oil palm, flax straw and wheat have proved to be a good and effective reinforcement in the thermo-set and thermo plastic matrices[9-13].In the present work we have prepare the bio-waste polymer matrix composite and experiments were done to analyze mechanical properties such as hardness, flexural strength. Frequency dependence of dielectrical properties at room temperature also evaluated.

Materials and Methods

Fabrication of the composite

Composite has prepared by using the epoxy resin LY556 as matrix, which is chemically belonging to the epoxide family. The hardener with IUPAC name NNO-bis used with epoxy has the designation HY-951, supplied by Ciba Geigy India Ltd. Resin and hardener are mixed in the ratio of 8:1 by weight as recommended. Coir dust was mixed with the epoxy by stirring at room temperature and square shaped samples with different amount of coir dust(0,10,20,40,and 60 wt%) were prepared, the designation of samples as sample A,B,C,D, and E respectively(for 0,10,20,40,and 60wt% of coir dust).

Mechanical properties characterization

Bulk density of the composite material obtained by using the Archimedes principle. The flexural strength of the material obtained by performing the short beam shear (SBS) test on the samples at room temperature. The SBS test is conducted as per ASTM D2344-84 using the Instron 1195 UTM.To evaluate hardness of the composite here we have used Leitz-micro hardner tester which is having a diamond indenter, in the form of a right pyramid with a square base and an angle 136° between opposite faces. Salorton 1296 dielectric interface instrument was used for carried out the dielectric measurement. Dielectric constant (K) and dielectric loss can be evaluated by observing capacitance and conductance measurement from the experiment.

Results and Discussion

Figure 1 shows the effect of reinforcement amount on the density of the composite material , from the figure it was clear that with increasing coir dust amount density of the composite decreases this is due to the presents of high air content (from 24% to 89% by volume),that is void fraction of the material increases with increasing reinforcement content.

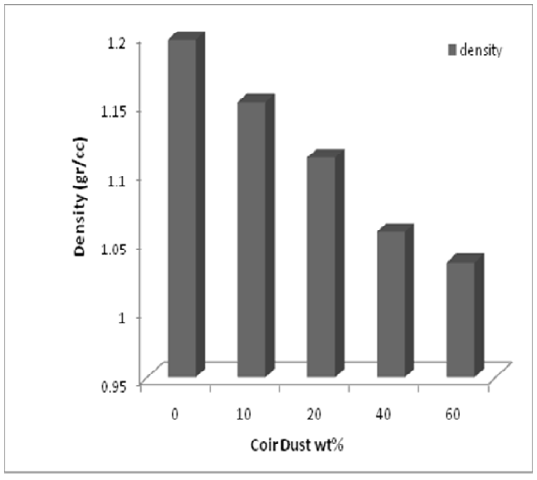

Figure 1: Variation of the density of the composite as a function of coir dust amount

Figure 2 gives the variation of the micro hardness and flexural strength of the composite as a function of coir dust content at room temperature.From the graph it is clear that with increasing coir dust amount hardness of the composite was decreased due to the softness of the coir dust compare with the matrix material , and flexural strength of the material decreases with increasing amount of coir dust,it may be due to increment in the void fraction .

(a) (b)

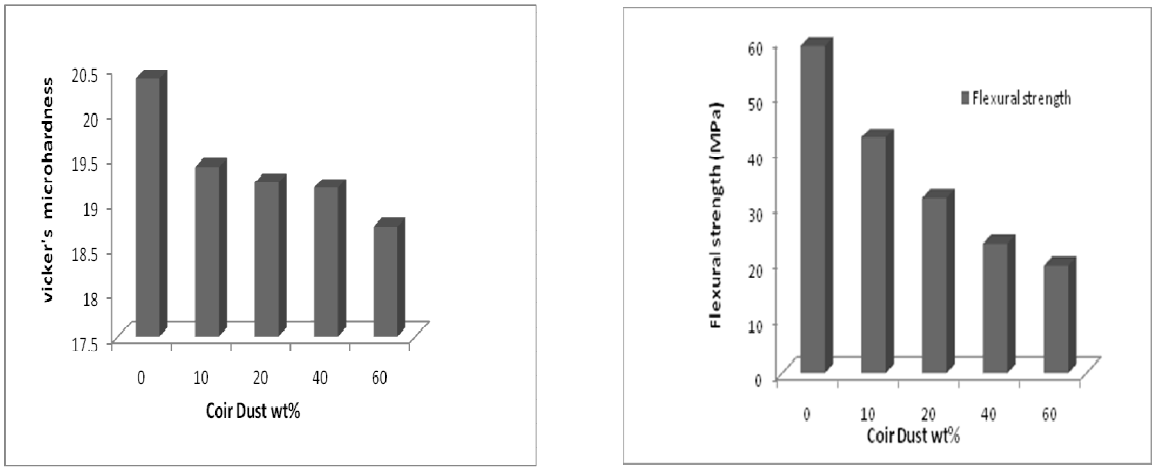

Figure 2: Influence of coir dust amount on (a) microhard ness and (b) flexural strength of the composite at room temperature

Figure 3 shows that the influence of the frequency of applied electric field on the dielectric constant(K),and dielectric loss(tan δ) for different amount of coir dust composites.From the figure it was clear that the value of K and value of tan δ are increases with increasing coir dust amount due to the absorption of moisture at the fiber resin interface,as the dielectric constant of water is very high.It is also be noted that with increasing frequency the value of K decreses because of the orientation polarization ,which is oftenly knows that anamalous dispersion.The value of tan δ is decreases with increasing frequency it was usual behaviour of most of the dielectric materials.

(a) (b)

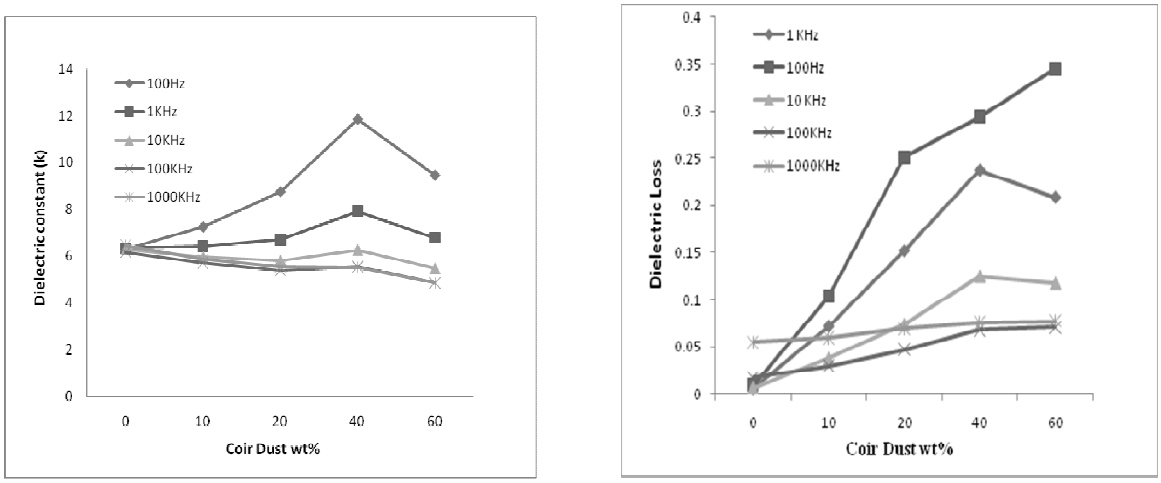

Figure 3: Effect of frequency on (a) the value of K and (b) the value of tan δ for different amount of coir dust composites at room temperature.

Conclusion

Mechanical properties such as micro hardness and flexural strength of the bio waste polymer matrix composite were evaluated, experiments shows that decrement of the hardness and flexural strength with increasing coir dust amount is due to the softness of the coir dust and increment in the void fraction. It is also observed that frequency dependence of the values of K and tan δ of the composite material at room temperature is affected by the amount of coir dust impregnation. The value of K and tan δ are increased with increasing the amount of coir dust and decreases with increasing (testing) frequency.

References

1.Arebelaiz A,Fernadez B ,Cantero G ,LanoPonte R ,Vlela A ,Monfrago I,

Composite Part A:Applied Science and Manufacturing ,36(2005) 1637.

2. Laly A ,Pothan ,Zacharia Ommen, Sabu Tomas,Composite science and Technology 63(2003)283.

3. Wang W ,Sain P ,Cooper A , Composite Science and Technology, 66(2006)379.

4.Ning X and Lovell M.R, ASME J Tribol,124 (2002) 5-13.

5.Pihtili H and Tosun,Wear ,252 (2002) 979-984.

6. Aoi N,Jpn.J.Appl.Phys, 36 (1997)1355.

7.Wu W,Waiiace W E,Lin E K,Lynn G W,Glinka C J ,Ryan E T , Ho H M J.Appl.Phys.,82(2000)1193.

8.HJo M,Park H H,Kim D J ,HyunS H,Choi S Y ,Paik J T,J.Appl.Phys.,87(1997)1299.

9. Bullers of Milton Sue Taylor,Churnet Valley Books.2003 ISBN 1-897949-96-0.

10. Hornsby P R, Hinrichsen E ,Tarvedi K, J Mater Sci,32 (1997) 1009-1015.

11. Tong J ,Arnell R D & Ren L Q ,Wear ,221 (1998) 37-46.

12. Pothana L A , Oommenb Z ,Thomas S, Compos Sci Technol, 63(2) (2003) 283-293.

13. Roe P J & Ansel M P ,J Mater Sci,20 (1985) 4015.