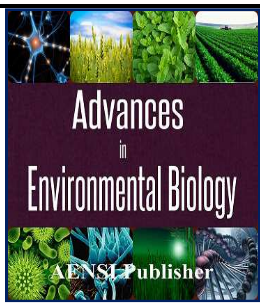
Advances in Environmental Biology, 10(7) July 2016, Pages: 116-122

AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/



Experimenting and Analyzing Electrical Conductivity of Natural Fiber Composites

[1]Amuthan. T and [2]Dr. Paramasivam. V

[1]Department Of Mechanical Engineering,Velammal College Of Engineering And Technology, affiliated in anna university, Madurai to Rameshwaram High Road, Viraganoor, Madurai, Tamil Nadu ,India-625009.
[2]Department of Mechanical Engineering, Psna College Of Engineering And Technology, affiliated in anna university, Kothandaraman Nagar, National Highway 209, Dindigul, Tamil Nadu India-624622.

Address For Correspondence:
Amuthan. T., Department Of Mechanical Engineering, Velammal College Of Engineering And Technology, affiliated in anna university, Madurai to Rameshwaram High Road, Viraganoor, Madurai, Tamil Nadu, India-625009.
Ph: +91-8012957158.E-mail: amalthan@gmail.com

Received 12 June 2016; Accepted 28 July 2016; Available online 25 August 2016

ABSTRACT

Natural fiber composites are getting more attention and importance over synthetic fibers in terms of their various advantages and applications. It is well known that electrical applications of natural fibers depend on the electrical conductivity of the composites. The electrical conductivity varies because of moisture absorption of the natural fiber based plastic composites. It is a major application of the natural fiber composite outdoor applications. The waterless natural fiber composite has no assessable electrical conductivity. After absorbing moisture from the atmosphere the fiber electrical conductivity of the composites gets vary. The electrical conductivity increases, according to the amount of fiber loading. The main objective of this paper is to design an experimental setup for measuring the electrical conductivity of natural fiber composite and which is cost effective over other ready-made setups already available. In this paper a proper setup is applied to measure the electrical conductivity of the natural fiber composite sample at different fiber loading and it gives the conductivity values. These values are close to the conductivity values obtained from earlier approaches and are increasing in term of increased fiber loading.

KEYWORDS: Natural Fibers, Electrical Conductivity, Natural Fiber Composites, Electrical Properties.

INTRODUCTION

Mix of two materials is called as composites where one material is called as the support as particles and the second one is installed in the other one called as network stage. Purpose behind making composite materials is to get the whole best properties from both the material without yielding on the shortcoming of either. The size, shape, volume deviation of the fortification response of the interface network material is the mechanical properties of the composites. An organization of both materials ought not influence the attributes of each other and hold their qualities and just the upsides of both materials enhance the nature of the composite material [6]. Lattice and support are the two classifications of constituent materials consolidated in the composite material. The fortification material is encompassed and bolstered by the network material. In the meantime it keeps up the relative position of the fortification material. Physical and mechanical properties enhance the network properties. Various strategies used to change the common fiber surface into the fiber surface. In the late world, it is crucial to make new items having more proficient material to create different sorts of new items. Composites generation assumes an indispensable part where solid burden material is installed in weaker material where it uses weaker materials as helpful and financially savvy.

Advances in Environmental Biology, 10(7) July 2016, Pages: 116-122

Related Works:

These days, common strands are acquiring impressive consideration used for making polymer composites. Since the mechanical properties of the common filaments, they have been used as a principle fortification material in polymer composites. Likewise characteristic filaments are costless, low thickness and noteworthy preparing favorable circumstances. [1-3]. It likewise renewable, less expensive in cost, don't make any wellbeing perils lastly; it can give an answer for ecological contamination by finding new uses for waste materials. More plant filaments have discovered applications as an asset for mechanical material [4, 5]. All in all composite materials are utilized as terminals, connectors, house hold plugs, witches printed circuits and industrials. More sort of conduct decides the usage of the normal filaments. They are electrical conduct, mechanical conduct etc. A composite material used in electrical applications is controlled by the properties like dielectric steady, volume resistivity and misfortune component [7]. They watched that the expansion in the dielectric consistent of composite with fiber stacking was because of expanded introduction and interfacial polarization. The electric properties of sisal fiber strengthened composite demonstrated that the composite has electric anisotropic conduct [8].

Matrix Phase:

Matrix phase is the primary phase and it is having a continuous character. It is more ductile and this phase is less hard and it holds the reinforcing phase and shares a load with it.

Reinforcing Phase:

Embedding the matrix in a discontinuous form is the second phase and it is called as reinforcement phase, which is stronger than the matrix phase.

Composites and Types:

The composites are classified into two main phases as matrix phase and reinforcing phase. The Matrix phase is divided into Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMC) and Polymer Matrix Composites (PMC).

Matrix Phase:

MMC is formed by a metal framework and a scattered earthenware or metallic stage. The metal grid implies any of the aluminum, magnesium, iron, cobalt and copper. The scattered artistic means any of oxides or carbides and metallic means lead, tungsten and molybdenum. MMC gets more preferences as far as solid metals. The solid metal is as high particular quality, higher particular modulus and better properties at higher temperatures and at lower warm extension coefficient. CMCs are included artistic lattice, fired network fortified with short strands, or stubbles like those produced using silicon carbide and boron nitride. A portion of the earthenware strands is utilized as a part of high temperature applications and in danger environment assault. Alumina and Silicon Carbide are fired filaments.

PMCs are involved thermosetting, thermoplastic and implanted glass, carbon, steel or Kevlar strands. When all is said in done regularly utilized network metals are polymeric. Handling of PMC need not include high weight and don't require high temperature. Likewise the gear utilized for PMC assembling is exceptionally basic.

Reinforcing Material:

Fiber and matrix are combined into have a fiber reinforced composites commonly. During the reinforcement phase the fiber and the main source of strength are forced together in terms of shape and transfers stresses among the reinforcing fibers. The load is carried from fibers along their longitudinal direction. In general the fiber reinforcing agents consists of aluminum oxide, carbon graphite fibers, beryllium, asbestos, molybdenum, beryllium oxide, bio fibers, glass fibers, polyamide etc. Similarly commonly used matrix material consists of epoxy, polypropylene, phenolic resin, vinyl ester, polyester, polyurethane etc. Polyester is commonly used as a resin material throughout the world. The matrix reinforced using a dispersed phase in the formation of particles. Small metal particles like aluminum and amorphous material, mineral particles contains carbon black and polymers. Because of the particles modules of the matrix is getting increased and the ductility of the matrix is getting decreased. All the particles are mainly used to decrease the cost of the composites. For example, in particle reinforced composites is an automobile tire, where it has carbon black particles in a matrix of poly-isobutylene elastomeric polymer.

Natural Fiber Composites:

In recent days in order to manufacture composite materials, natural fibers are mostly used because it is cost effective to make synthetic fiber reinforced composites. Also, it is easy in manufacturing and availability of natural fibers is more and flexible to get locally for reinforcement. The availability and accessibility of natural fibers is easy and it is inexpensive. The purpose of reinforcement using the natural fibers is satisfying the user requirement up to theirs extends. Also the reinforcement can produce more polymer composites for various kinds of applications. The mechanical behavior of the natural fibers provides good renewable alternatives to synthetic reinforcement like glass fibers with low cost with biodegradable. The harvesting of natural fibers reached 1000,000 tons per annum in 2010. Harvesting of natural fibers includes technical innovation, continuing political and environmental pressure, identification of new applications etc. The values of the natural fibers are better than glass fibers when considering certain modulus of it. It is easy to save the cost of natural fiber, by filling levels, mixing, non-abrasive to mixing and modeling equipment. The benefits of the natural fibers are: It can be used in various kinds applications like:

- Automotive
- Building
- Household appliances

For example the following figures show the natural fiber reinforced composites used in various kinds of applications is shown in the following Figure-1.

Automotive Building Household Appliances

Electrical Devices

Fig. 1: Various Applications of Natural Fibers Composites

The matrix phase is some natural fiber during the reinforcement phase may be thermoplastic material or epoxy, polypropylene etc., is called as natural fiber composite. In the recent days due to a wide range of applications utilizes mostly natural fibers such as polymer composites are reinforced with natural fibers due to cost and the natural fibers are very cheap, abundantly available and renewable. Natural fiber composite reinforced with thermoplastic material is more economic since it produces the original thermoplastics [9].

Engineering field such as dielectric is drastically growing important in terms of producing applications of composite materials. So that investigating and studying the electrical behavior of the natural fiber reinforced thermoplastic composites are more important [10]. Natural fiber composites are very famous and popular among people due to its cost, lightweight, high stiffness, strength, corrosion resistance and lower impact on the environment. Because of their quality, durability and other advantages, they are used to make a large variety of floor mats, yarn, rope etc. Plants, such as jute, sisal, kenaf, pineapple, flax, cotton, hemp, ramie, bamboo, banana, etc., as well as wood, a source of lignocellulose fibers, are usually applied as the reinforcement of composites. Their reliability, availability, low density, and price as well as overall good mechanical properties make them an attractive ecological alternative to glass, carbon and synthetic fibers used for the manufacturing of composites. Some natural fiber composites are: Bast fibers (flax, hemp, jute, kenaf…)-wood core surrounded by stem containing cellulose filaments, Leaf fibers (sisal, banana, palm), Seed fibers (cotton, coconut coir).

Generally, plant or vegetable fibers are used to reinforce polymer matrices of natural fiber composites and plant fibers are a renewable resource and have the ability to be recycled which gives an extra edge over synthetic fibers.

Electrical Conductivity:

Mostly composites are used as substitutes in electrical applications as an insulator or a conductor. During used in electrical applications the composites are modified in terms of preparation, where it is more important to carry determined electrical conductivity of various natural fiber composites. Due to the properties obtained from the macroscopic of composite materials it can be understood that the abilities can be extended to which it can conduct electricity or behave as an insulator. According to the capability limitations the natural fiber composites can be used in the particular electrical system to pass a current through it. Composites have negligible conductivity, due to this it can be used as an insulator in different electrical circuits during high value of electrical conducting at endpoints needs good conducting material to provide good strength. One of the measurements to measure, to decide how a composite material can conduct electricity is electrical conductivity. The inverse of the conductivity is resistivity and can be denoted by sigma (**σ**), measuring how much the current flow is opposed.

The resistivity of a sample composite is calculated using the following equation as:

$$\rho = R\frac{A}{\ell}, \quad (1)$$

Where,

R - Denotes the electrical resistance of a uniform sample of the material (measured in ohm)

ℓ - Denotes the length of the piece of material (measured in meters, m)

A – Denotes the cross-sectional area of the specimen (measured in square meters, m^2)

From this the conductivity can be calculated using the following equation as:

$$\sigma = \frac{1}{\rho} \quad (2)$$

$$= L/(R \times A) \quad (3)$$

Where,

L - Denotes the length of the sample composites (in meter)

R - Denotes the resistance (ohm,Ω)

A - Denotes the cross sectional area of the specimen (sq. Meter)

SI - Denotes the units of the conductivity in Siemens per meter(S/m)

In order to measure and verify the electrical conductivity of the composite material an experimental setup is made. There are two aspects are used for verification, they are microscopic conductivity and macroscopic conductivity. Tiny conductivity relies on upon the inside elements, for example, doping level, chain length, conjugation length while naturally visible conductivity relies on upon outer elements, for example, the minimization of the specimens. By and large the outward conductive polymer composites' non-straight electrical conductivity can be depicted utilizing permeation hypothesis. Composites are having electrically protecting qualities by including directing added substance into polymers in every level of assembling. At the more elevated amount of including leading added substance into polymer permits the composites to end up an electrically semi-conductive. The conductive conduct relies on upon the volume division of the filling particles. On the off chance that the filling particles builds then the fiber groups gets to be bigger in the conduction ways which influences the directing conduct. An edge worth is relegated for filling the particles in the composites, to decide the conductive added substance nature. This edge quality is called as permeation limit. Over this edge esteem as the fiber content builds the conductivity of the specimen additionally increments.

MATERIALS AND METHODS

A characteristic fiber plastic composite with rice husk (normal fiber) as support stage in epoxy as the framework stage is ready. With a specific end goal to gauge and think about the execution as far as electrical conduct, there are four diverse rice husks is stacked in various proportions like 40%, half, 60% and 70%. Since rice husk is a sinewy material, the angle proportion is in a fluctuated extent and its organization makes a potential channel for making lightweight polymer composites.

A portion of a composite sheet is cut out from a whole sheet in a sample dimension like 4 cm x 4 cm x 1 cm. This sample is dipped in distilled water at room temperature 23’C. After some time, the sample is taken out from the distilled water and the surface is removed by tissue paper, and their electrical conductivities were measured immediately shown in Figure-2.

Advances in Environmental Biology, 10(7) July 2016, Pages: 116-122

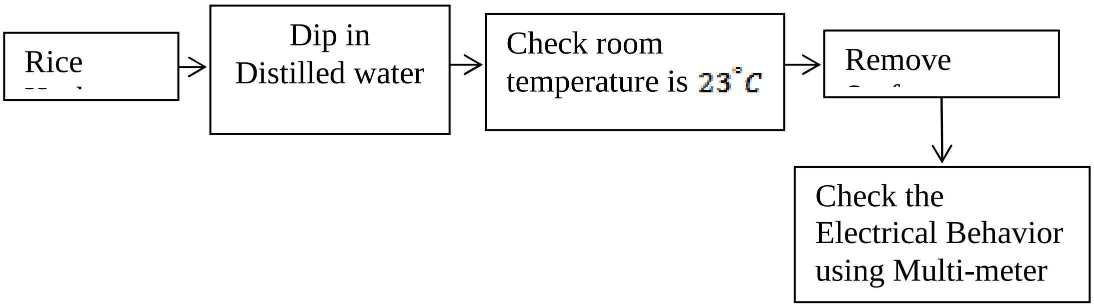


Fig. 2: Experimental Procedure

Experimental Procedure:

It is not able to measure the electrical resistance since it is dry and the electrical resistance is so high for the sample. By using a multi-meter it verifies that the electric current passing through the sample and it is measured after moisture absorption. In order to measure the electrical conductivity a proper electrical set up is established and shown in Figure-3 and in Figure-4.

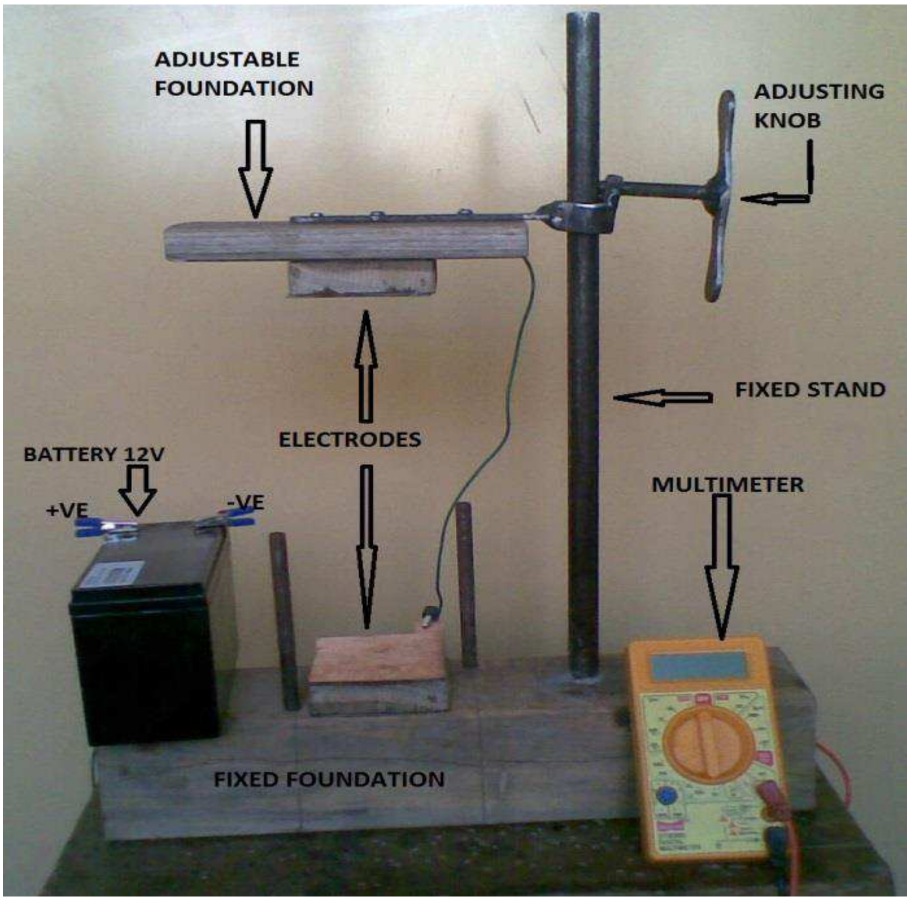


Fig. 3: Experimental Setup for Measuring Current Measurement

The above figure is the trial set-up made for measuring electric current coursing through the composite from which resistance and subsequently conductivity are computed. A 12Volt battery is the wellspring of energy to the circuit. Altered single side directing copper plates goes about as anode plate. One of the plates is altered to the settled establishment while the other plate is altered on the flexible establishment whose stature can be balanced while evacuating and putting the composite example on the anode connected to settled establishment. The customizable establishment would me be able to moved down utilizing changing handle and fixed utilizing the two jolts with the altered establishment. One terminal of battery is specifically associated with the plate over customizable establishment which is negative terminal, thus the altered establishment plate is the cathode. The other terminal of the battery is experiences the computerized multi meter which associated in arrangement with

Advances in Environmental Biology, 10(7) July 2016, Pages: 116-122

the circuit for current estimation. In the first place the settled resistance of the circuit is computed by short circuiting the circuit and after that the composite example is put on the altered establishment and the customizable establishment is purchased down and after that fixed with adequate weight utilizing the jolts as appeared as a part of fig. 3 beneath and the present perusing is noted down on the advanced multimeter.

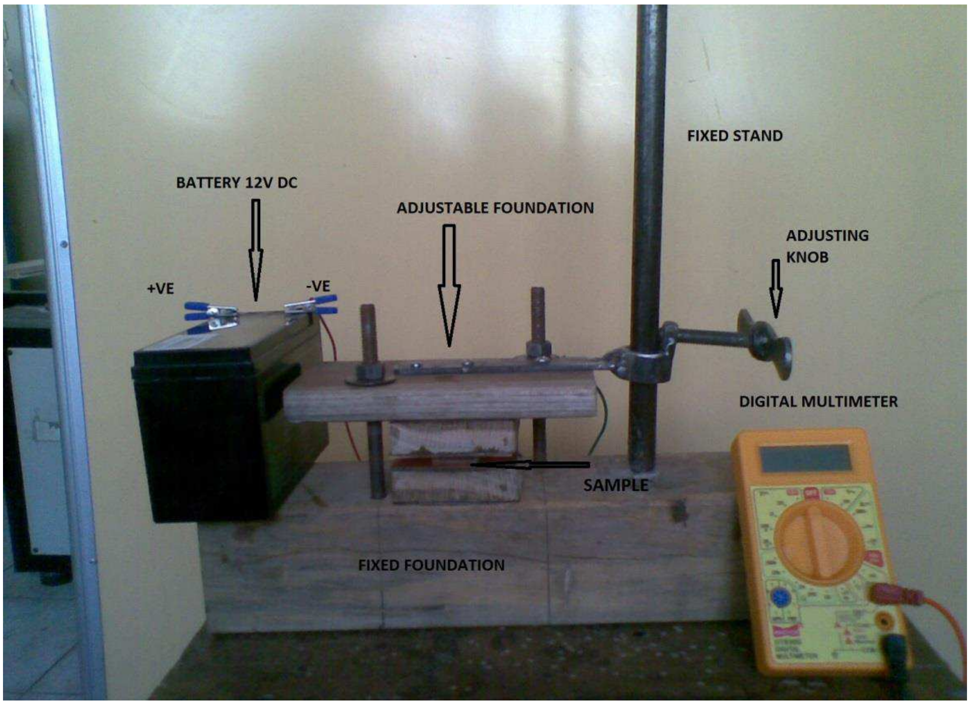


Fig. 4: Experimental set-up of electrical current measurement (with sample)

The resistance of the circuit is calculated using:

$$R_0 = \left(\frac{V}{I}\right) \tag{4}$$

Where, V is the voltage of the short-circuit (12V), and I is the current of the short circuit on multi-meter=0.667 amp

So,

$$R_0 = 18V \tag{5}$$

Then the resistance of the circuit is calculated as:

$$R = \left[\left(\frac{V}{I}\right) - R_0\right] \tag{6}$$

and finally the electrical conductivity is calculated using:

$$\sigma = \left[\frac{L}{(R \times A)})\right] \tag{7}$$

Where,

L = length of sample = 0.4 cm = 0.004m

A is the area of sample in contact with electrode = 2 x 2 = 4 cm^2= 4 x 10^{-4} m^2

RESULTS AND DISCUSSION

The 40% of the fiber is experimented and the current value is measured by the multi-meter, where it shows 0.0132 ampereof current through the sample. Same time resistance is calculated using the equation (6). The multi-meter shows 909 kilo-ohms. Then, using equation (7) the measured conductivity is measured as 1.1 x 10-5 ohmmeter ($\Omega - m$). This experiment is repeated for all the other fiber samples and experimented. The obtained results are shown in the following figure.

Advances in Environmental Biology, 10(7) July 2016, Pages: 116-122

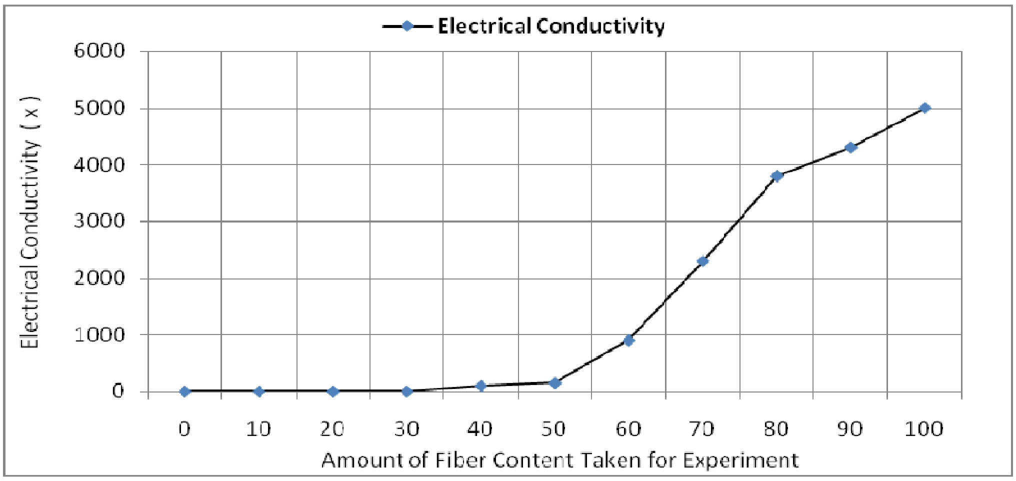


Fig. 5: Comparison of Electrical Conductivity on Different Samples

Conclusion:

This paper motivated to investigate the electrical behavior of the natural fiber composites. From the experimental investigation, it is concluded that the proposed conductivity values are very near to the earlier results obtained from earlier research works. The experimental setup is cost effective than buying a ready-made machine in order to experiment and measure the electrical properties of the composites. According to the natural fiber content increases beyond the percolation threshold value, then the electrical conductivity also increases. This experimental setup can be modified further by using other materials like iron, steel or alumina in place of wood to manufacturing adjustable fixtures and fixed foundations which could not be done due to time constraint. It can also be used for measuring electrical conductivities of composites, other than natural fiber composites with small required modifications.

REFERENCES

[1] Pathania, D and D. Sing, 2009. A review on electrical properties of fiber reinforced polymer composites, International Journal of Theoretical & Applied Sciences, 1(2): 34-37.
[2] Satyanarayana, K.G., K. Sukumaran, P.S. Mukherjee, C. Pavithran and S.G.K. Pillai, 1984. International conference on low cost housing for developing countries, pp: 171-181.
[3] Satyanarayana, K.G., B.C. Pai, K. Sukumaran and S.G.K. Pillai, 1990. *Lingocellulosic fiber reinforced polymer composites* (New York, Marcel Decker, 1: 339.
[4] Thomas, S. and G. Udo, 1997. *Ligno. Plast.Compos.*, 181.
[5] Rowell, R.M., A.R. Sanadi, D.F. Caulfield and R.E. Jacobson, 1997. *Ligno. Plast.Compos.*, 21.
[6] Berghezan, Nucleus A., 8(5), 1966, (Nucleus A Editeur,1,rhe,Chalgrin,Paris, 16(e).
[7] Morsli, M., A. Bonnet, F. Samir and S. Lefrent, 1996. J. Appl. Poly. Sci., 61: 231.
[8] Chand, N. and D. Jain, 2005. Compos. A, 36: 594.
[9] Maldas, D., B.V. Kokta, R.G. Raj and C. Danealut, 1988. Polymer, 29: 1255.
[10] Paul Augustine and Thomaszsamu, 1997. Journal of Applied Polymer Science, 63: 247-266.