International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064, Impact Factor (2013): 4.438
www.ijsr.net

Effect of Frequency on Physical Properties of Date Palm Fiber -PVA Composites

A.Sarangi[1], G. Nath[2], [3]S.K.Swain[3], R.Paikaray[4]

[1]Department of Physics, Christ College, Cuttack, Odisha, India

[2]Department of Physics, Veer Surendra Sai Univesity of Technology,Sambalpur, Burla, Odisha, India

[3]Department of Chemistry, Veer Surendra Sai Univesity of Technology,Sambalpur,Burla,Odisha, India

[4]Department of Physics, Ravenshaw University, Cuttack, Odisha, India

Abstract: ***The date palm fiber-PVA composites solution was prepared with different ratios of concentration. Ultrasonic waves of different frequencies are allowed to pass through composite solution. Acoustic properties like acoustic impedance, bulk modulus are calculated using measured ultrasonic velocity and density data. The absorption coefficient is calculated using Beer– Lambert law. It is found that the ultrasonic velocity, acoustic impedance and bulk modulus are decreasing with increase of frequency.The results shows that ultrasonic wave made degradation to the randomly coiled polymer chain, when ultrasonic frequency increases for which date palm fiber-PVA composite acts as a good ultrasonic absorber.***

Keywords: Date palm fiber-PVA composites, ultrasonic velocity, acoustic impedance, bulk modulus.

1. Introduction

The study of composite materials mixtures consisting of at least two phases of different chemical compositions has been of great interest from both fundamental and practical purpose. Composite materials structural integrity can be observed via many mechanisms including presence of discontinuities or loss of mechanical properties. Ultrasonic technique is good method for studying the structural changes associated with the information of mixture assist in the study of molecular interaction between two species. The manner in which the propagation of the ultrasonic wave is affected by structure of the material results in parameters that can lead to the characterization of the material. The absorption of ultrasound in polymer composite systems is governed by local modes of motion and cooperative because of the existence of strong intermolecular interaction within the polymer.

2. Sample Preparation

PVA with 99.3 % assay and date palm fiber as powder material is ground for 6 hours. Then the powder was separated by laboratory test sieve type with size (0.038 mm) to separate the fine pieces from large one then the fine pieces were grounded again for 3 hours and separated by another test sieve type with size 150µm t o obtain the palm fiber in powder, this composite prepared by a solution casting method. The appropriate weight ratios of PVA are constant (1gm) were dissolved in (20ml) distilled water under stirring and heat (90^0C) for (1 hour) the palm fiber powder was added slowly with stirring to the solution with the ratios (0.1, 0.2, 0.3 0.4 0.5) gm, the resulting solution was stirred continuously until the solution mixture became a homogeneous at room temperature for (30 min.).The concentration under study was 0.004gm/ml.

3. Ultrasonic Measurements

Ultrasonic measurements were made by interferometric technique with different frequencies, in which the receiver quartz crystal mounted on a digital vernier scale of slow motion, the receiver crystal could be displaced parallel to the sender and the samples were put within the cell. The sender and receiver pulses (waves) were displaced as two traces of maxima and minima, which is digitally display in screen. The absorption coefficient (α) was calculated from Beer– Lambert law equation

$$A/A_0 = e^{(-\alpha x)} \quad \ldots\ldots (1)$$

where (A_0) is the initial amplitude of the ultrasonic waves, (A) is the wave amplitude after absorption. The method of measuring the speed of ultrasound was by noting the maxima or minima deflection of the pointer of the reading scale of the interferometer. This data will help to calculate the wave length in the different concentration of the sample for a given frequency of the interferometer. The ultrasonic velocity was calculated from the relation

$$v = f \lambda \quad \ldots\ldots (2)$$

The acoustic impedance of a medium (Z) is a material property was calculated by this equation where (ρ) is the density of the sample

$$Z = \rho v \quad \ldots\ldots.. (3)$$

The bulk modulus (B) of a substance was calculated by following equation

$$B = \rho v^2 \quad \ldots\ldots. (4)$$

Compressibility (β) is a measure of the relative volume change of a fluid or solid as a response to a pressure (or mean stress) change, it was calculated by the equation

$$\beta = (\rho v^2)^{-1} \quad \ldots\ldots.. (5)$$

4. Results and Discussions

The wavelength was determined from two traces of maxima and minima, which is digitally display in screen by the sender and receiver pulses (waves). The wavelength of ultrasonic wave is decreasing with increasing of frequency as wavelength inversely related to the frequency (Fig.1).

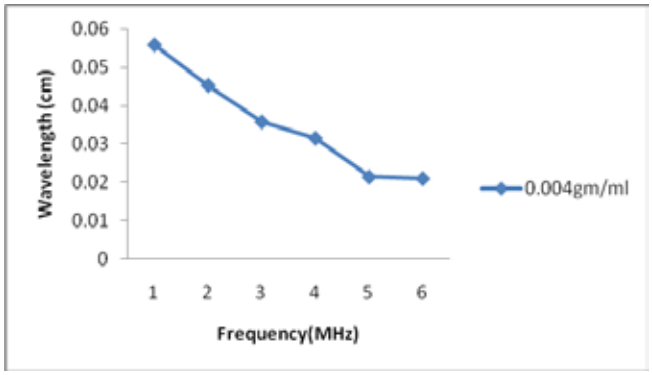

Figure 1: Variation of wavelength with frequency

Ultrasonic velocity is decreasing with increase of frequency which could be attributed to ultrasonic wave made degradation to the polymer chains, chain breaking of the polymer results in a slight decrease in the tensile properties which can be attributed to the decrease in the number of tie-chains [1-3].

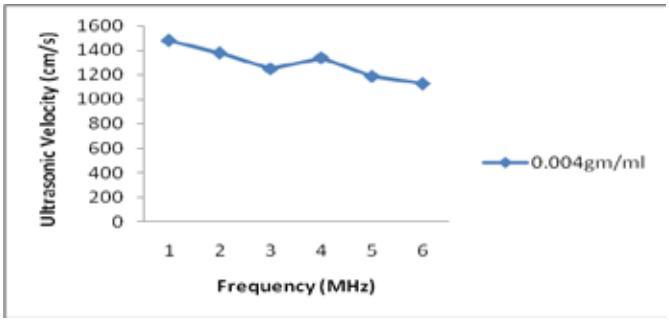

Figure 2: Variation of ultrasonic velocity with frequency

Since frequency related to energy ,when the frequency increases incident energy also increases then degradation must increasing which reduced the number of tie-chains, so the velocity decreased.

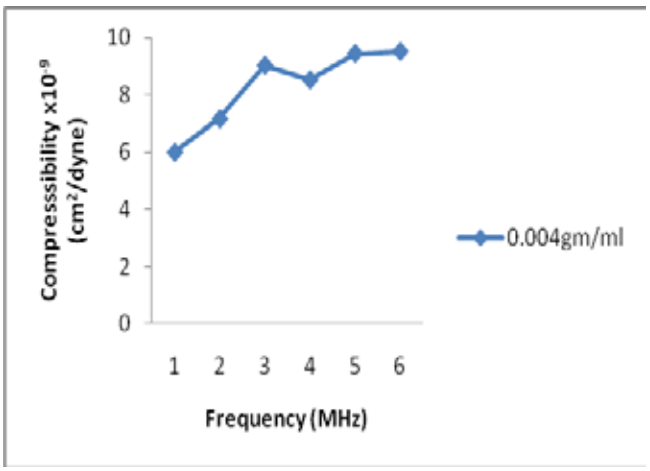

Figure 3: Variation of compressibility with frequency

The compressibility increasing with the increase of ultrasonic frequency as shown in Fig.3.This attributed that ultrasonic wave transfer as compression and rarefaction, results in degradation of the polymer chains that randomly coiled and the broken chains compresses during ultrasonic propagation that reduces molecular configurations. Since more degradation happen at high frequency it increases the elasticity so it is easy for molecules to be compressed [4-5].

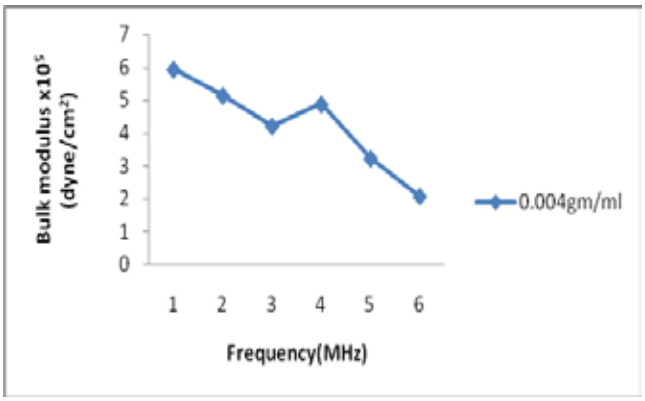

Figure 4: Variation of bulk modulus with frequency

The bulk modulus are decreasing with increase of frequencies as shown in Fig.4.This could be attributed to the amount of contraction is governed by the compressibility, which is dependent on the intermolecular forces.

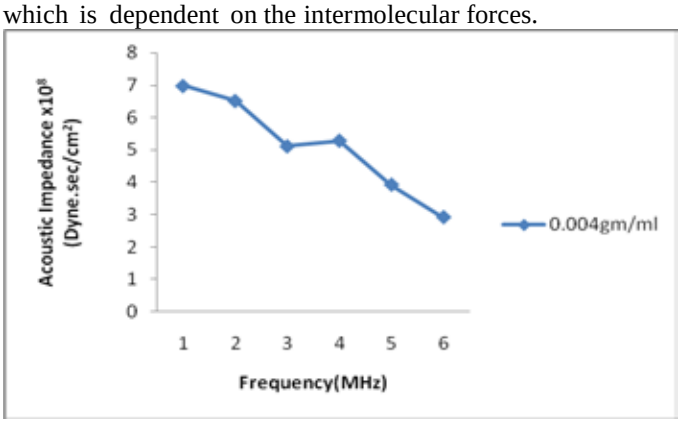

Figure 5: Variation of acoustic impedance with frequency

The specific acoustic impedance is decreasing with increasing frequency as shows in Fig.(5),this attributed that ultrasonic waves made degradation to the polymer chains that resist the waves to transfer and gave the membrane good acoustic impedance[7-9].

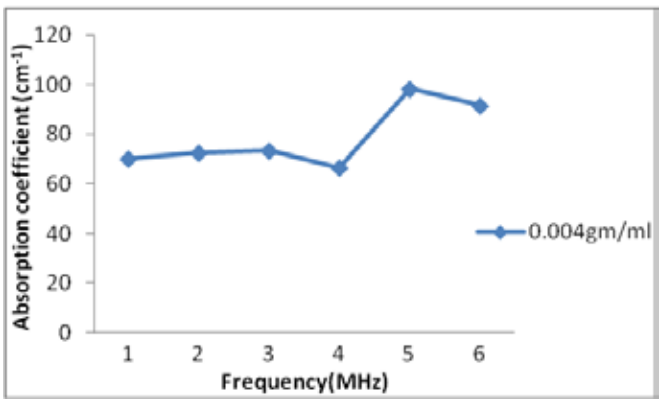

Figure 6: Variation of absorption coefficient with frequency

The absorption coefficient of the ultrasonic waves are increasing with increasing frequency as shown in Fig.(6) , this attributed when the frequency increasing the vibration increasing causes increasing and decreasing in pressure relative to atmospheric pressure. The compression and rarefaction decreasing by displacement of the molecules from their equilibrium positions so as a result to high frequency there are more degradation to polymer chains then increasing in absorption by composite.

5. Conclusion

It is found that the date palm fiber – PVA composite absorbs different range of ultrasonic frequencies and can be applied in different surfaces that need this property. Palm fiber –PVA composite damping ultrasound velocity for different range of frequencies. Palm fiber – PVA composite is not good medium for transferring ultrasonic waves.

References

[1] Tomasz Hornowski, Arkadiusz Józefczak ,Andrzej Skumiel and Mikołaj Łabowski (2010) **,**Int J Thermo phys. , Vol.31,No.1, pp.70–76.
[2] E.Foled, M.Iring and F.Tudds (1988), Polymer Bulletin J.Vol.20, no.1, pp.89-96.
[3] Formageau J., Brusseau E. Vary D., Gimenez G. andChartre P.(2003), IEEE transactions on ultrasonic ferroelectrics and frequency control,Vol.50,issue 10 pp. 1318-1324.
[4] Hasun S.K.(1989),British polymer Jouranal, vol.21No.1 pp.333-338.
[5] Al-Bermany E. (2004) **,** M.Sc. thesis, Baghdad University.
[6] Hassina Khelladi, Frédéric Plantier, Jean Luc Daridon and Hakim Djelouah (2009), IEEE International Ultrasonic Symposium Proceedings,, pp.1567-1570.
[7] Wiggens P.M. and Van Ryn R.T. (1986), Journal of Macromolecules Sci.-Chem. A23, 875-905.
[8] A. K. Al-Bermany (2009),Journal of college of education, Vo.2, no.4,pp.34-42.
[9] Al-Bermany K.J.(2010), Journal of college of Education,Babylon university vol.1,no.5.pp.35-41.