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Comparison Study of Hardness ,Thermal Conductivity and Electrical Properties of White and Broun Chicken Eggshells

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Abstract
In this research work , white and brown chicken eggshells waste were used as a bio – $CaCO_3$ particles with different volume fractions 1 , 2 , 3 , 4 , 5 % to reinforced the epoxy . Hardness , thermal conductivity and electric properties ,like relative permittivity and resistivity tests performed on unfilled ,white and brown eggshell reinforced epoxy to identify the loading effect on the properties of materials .the test results exhibited a good improvement in hardness , thermal conductivity and relative permittivity .
Keywords : epoxy , eggshell , hardness , thermal conductivity , resistivity and relative permittivity .

1. INTRODUCTION

Epoxy resin (EP) is an insulation material . It is widely used in generator and solid cast transformer [1] .
Over the years , many attempts have been made to modify epoxy by adding fillers ,

The addition of fillers , on the other hand , improves the strength of epoxy , but decreases its fracture toughness [2].

Eggshell are meanly compose of calcium carbonate about 87 – 97 % [3, 4] , the eggshell used as reinforcement in polymer industry to improving mechanical properties [5] .

Eggshell has a relatively lower density compared to mineral calcium carbonate , Thus eggshell are inexpensive , lightweight and low load –bearing composite applications ,such as in automotive industry ,trucks , homes [6] .

Some of the work on the use of eggshell in polymer composites are : S.B. Hassan etal [7] , studied the use of eggshell in reinforcement of polyester , the work proved that polyester / eggshell particulate composite material showed a development in mechanical and electronic properties .

Torig A. Hassan etal. [3] studied the use of bio- based $CaCO_3$ nanofillers as reinforcement in polylite polymer . The test results showed significant enhancement in the mechanical properties due to the incorporation of the bio – based $CaCO_3$ nano particles by weight 2 % a substantial increase in the compressive strength (14.3 %) and modulus (27 %) compared to the neat system .

Okonkwo , U .N . etal. [8] studied the effect of eggshell ash on strength properties of cement – stabilized lateritic, this research showed that increase in eggshell ash content considerably increased ,the strength properties of the soil – cement eggshell ash mixtures up to 35% .

The present investigation has been focused on the use the white and brown eggshell with different volume fraction of addition to epoxy to improvement the hardness , thermal conductivity and the electrical properties like resistivity and relative permittivity at high rang of frequency 2000 Hz to 5 MHz .

2. EXPERIMENTAL

2.1 MATERIALS

The epoxy resin used in this work is the epoxy (Nitofill , EPLV with its hardener from fosroc Company) .
The eggshells used in this research were white and brown chiken eggshells from Baghdad , Iraq . The raw eggshells were washed with tap water and allowed to dry at room temperature .
Eggshells were grinded using a blender . Figure (1) shows the white and brown eggshell in two forms .

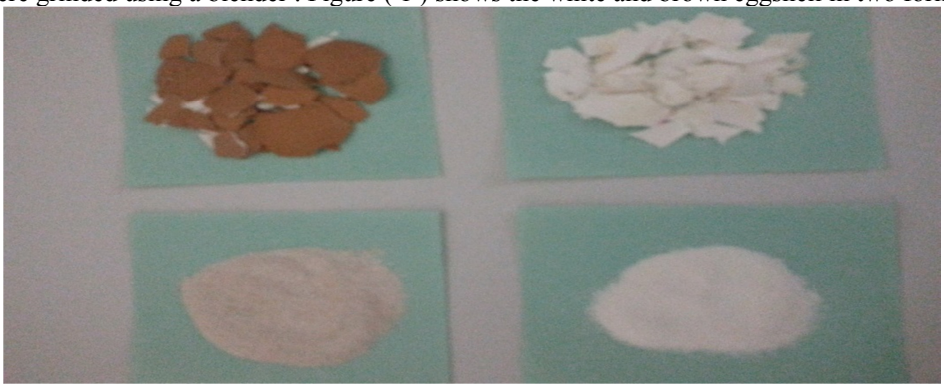

Figure (1) : White and brown eggshell samples before and after ground

2.2 Instruments

A digital weighing balance to prepared the different samples , shore D hardness machine for determined the hardness values of neat epoxy and epoxy composites , lee disk device for measuring the thermal conductivity and LCR meter model (GW INSTEK LCR -8105G , 20 HZ – 5 MHZ) to determined the electrical properties of samples .

2.3 METHOD

The epoxy resin was mixed with the hardener with ratio 3 : 1 without any reinforcement for casting of the control sample .

This mix was then poured immediately into the glass molds and was allowed for 7 days to cure .

The densities of the white and brown eggshell powders were obtained by weighing each on the digital weighing balance and then take the ratio of mass over the volume .

We add the white and brown eggshell powder to epoxy with volume fraction 1 , 2 , 3 , 4 and 5 % then molded the mixture in glass mold with rectangular shape at dimension (12 mm) length and (4 mm) width for hardness test and in dick shape with dimension (20 mm) in diameter and (2mm) in width for thermal and electrical tests .

The microstructure of samples , The hardness , the thermal conductivity (^{o}K) and electrical properties of the samples are determined .

3. RESULT AND DISSCUSION

3.1 DENSITY

The measuring density of white eggshell powder is (2 gm /Cm^3) while the density of brown eggshell powder is (2.2 gm / Cm^3) .

3.2 HARDNESS TEST

Figure (2) shows that the hardness of the brown eggshell reinforced epoxy composite is greater than that of white eggshell reinforced epoxy composite , this may be attributed to the fact that brown eggshell particles may contains more $CaCO_3$ and therefore increase the hardness of the composite [7] .The hardness value of the eggshell reinforced epoxy composite is more than that of neat epoxy , then the hardness value increase to an optimum value at 3% Volume fraction of eggshell addition , then it decreased steadily at 4% and 5% of eggshell addition .

The decreased in the hardness after the optimum are attributed to weak interfacial bonding , which resulted to weak the bending load carrying by the matrix [1].

Hardness depend on factors such as filler content , particle size and shape , the degree of adhesion between the filler and the polymer matrix and the dispersion of filler within the matrix [9] .

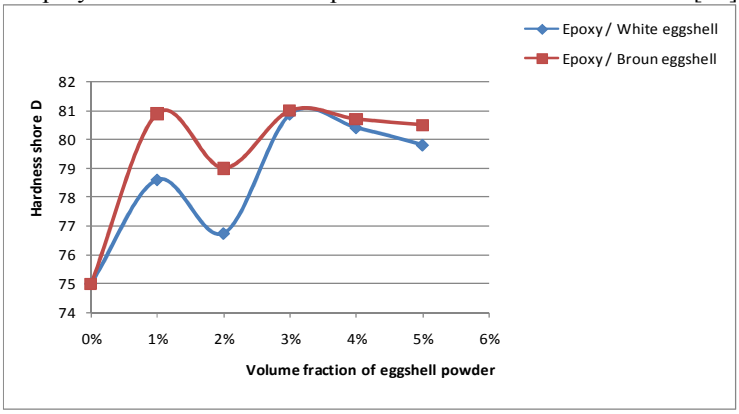

Figure (2) : Hardness value epoxy with white and brown eggshell powder with different volume fractions

3.3 THERMAL CONDUCTIVITY

The Thermal conductivity of epoxy / white eggshell powder and epoxy / brown eggshell powder is shown in figure (3) .

The thermal conductivity of the neat epoxy is (0.20 W /m.^{o}K) . The epoxy /White eggshell powder show higher than epoxy / brown eggshell powder at 1% , 2% of volume fraction and have the same values at 3% of addition ,with increase the loading to 4% and 5% the thermal conductivity of epoxy / brown eggshell powder is greater than of the epoxy / white eggshell powder . The improvement in thermal conductivity could be due to the presence of hyper branched epoxy leading to eggshell dispersing well in the matrix [1] .

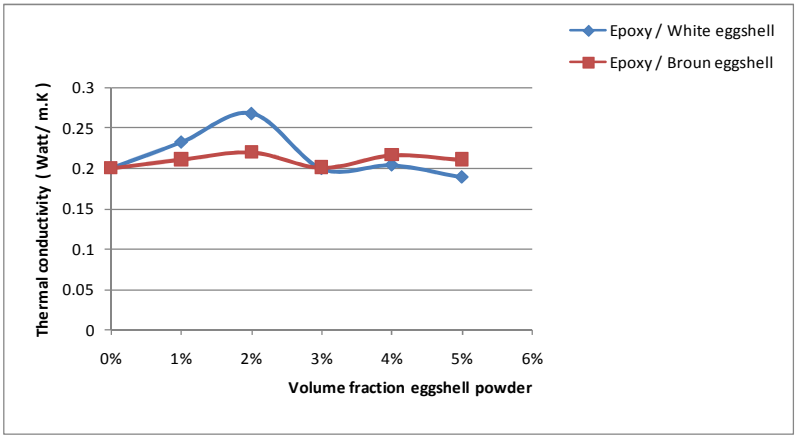

Figure (3) :Thermal conductivity of epoxy with white and brown eggshell addition .

3.4 ELECTRICAL PROPERITIES

At high rang of frequency from 2000 HZ to 5 MHZ , the relative permittivity of neat epoxy is increase by using the eggshell as reinforcement and it increase by increase the volume fraction of brown eggshell powder from 0% to 5% respectivily as, shown in figures (4).

By using the white eggshell powder as reinforcement the relative permittivity is increase with increase loading of addition from 0% to 3% and then degrease at 4% and 5% of loading , as shown in figure (5) .

At high range of frequencies , with loading 1% , 2% , 3% of fillers the relative permittivity of epoxy / white eggshell powder have a greater values than that of epoxy / brown eggshell powder , as shows in figures 6 , 7 and 8 respectively, but the relative permittivity of epoxy/ brown eggshell powder have a higher values than that of epoxy /white eggshell powder at 4% and 5% of loading , as in figures 9 and 10 respectively.

Figure (11) shows that the relative permittivity value of epoxy / white eggshell powder was higher than that of epoxy / brown eggshell powder and it is reach to optimum value at 3% of loading .

The resistivity have a higher value for epoxy / brown eggshell powder at 3% of loading at it have a lower value for epoxy / white eggshell powder at the same loading ,as shown in figure (12) .This due to the fact that resistivity's of composite are related to filler content , dispersion degree of partials . On the other hand the eggshell can combine with epoxy and act as crosslinking point ,which limited migration of the current carriers and with increasing loading content , the acting as crosslinking point decrease ,thus ,the resistivity decreases upon a certain loading content [1] .

So, the resistivity decrease and permittivity increased with increasing of volume fraction of eggshell ,which agree with the experimental data well [2] .

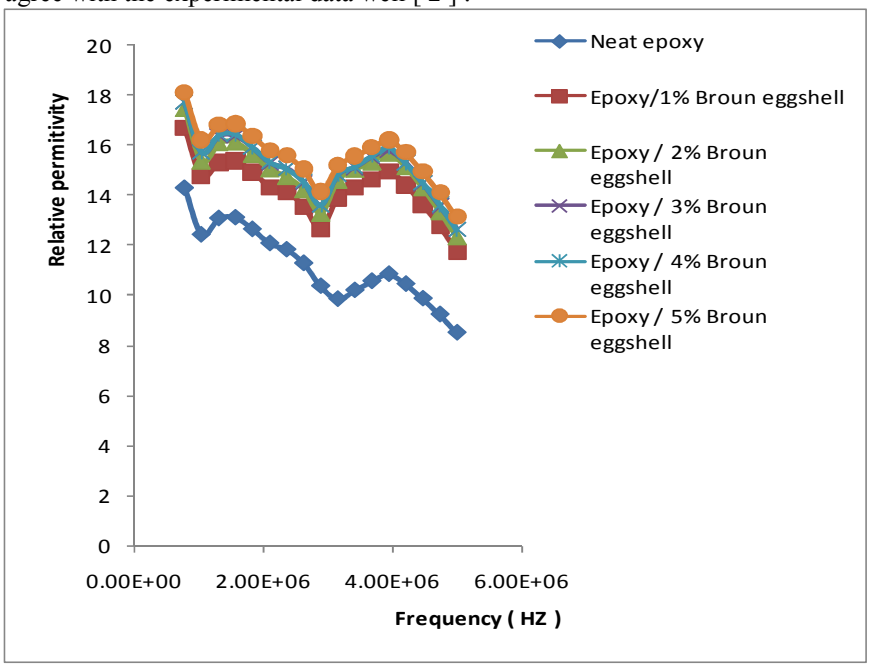

Fig. (4) : Effect of loading of brown eggshell on relative permittivity

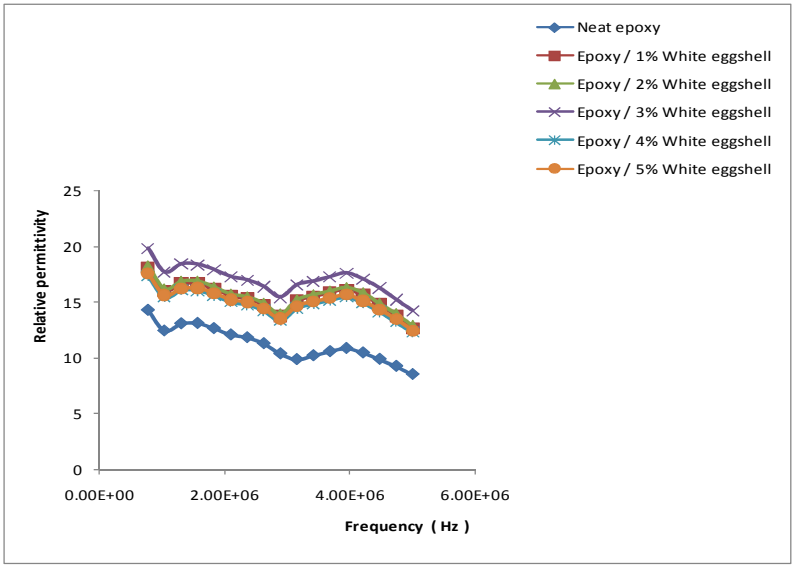

Fig. (5) : Effect of loading of white eggshell on relative permittivity

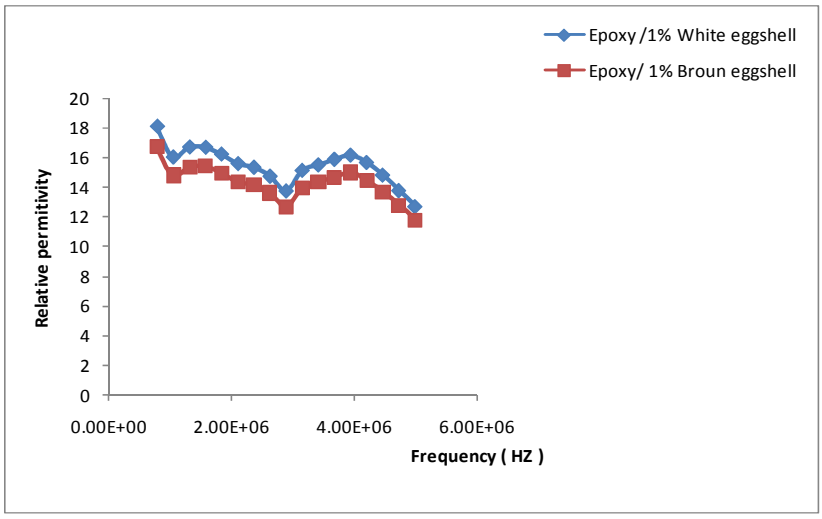

Fig.(6):Effect of kind of eggshell on relative permittivity at 1 % of addition

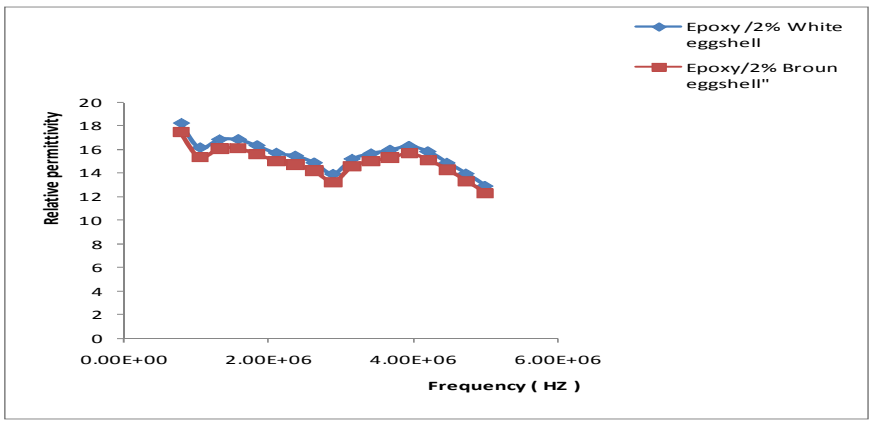

Fig.(7):Effect of kind of eggshell on relative permittivity at 2 % of addition

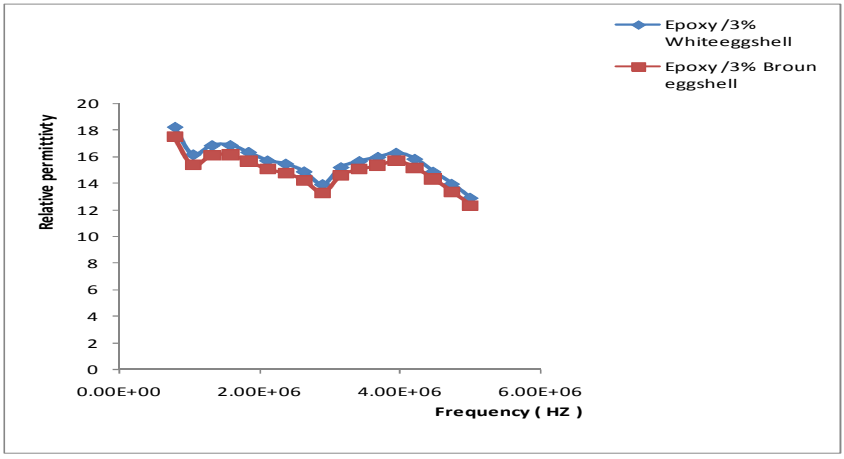

Fig.(8):Effect of kind of eggshell on relative permittivity at 3% of addition

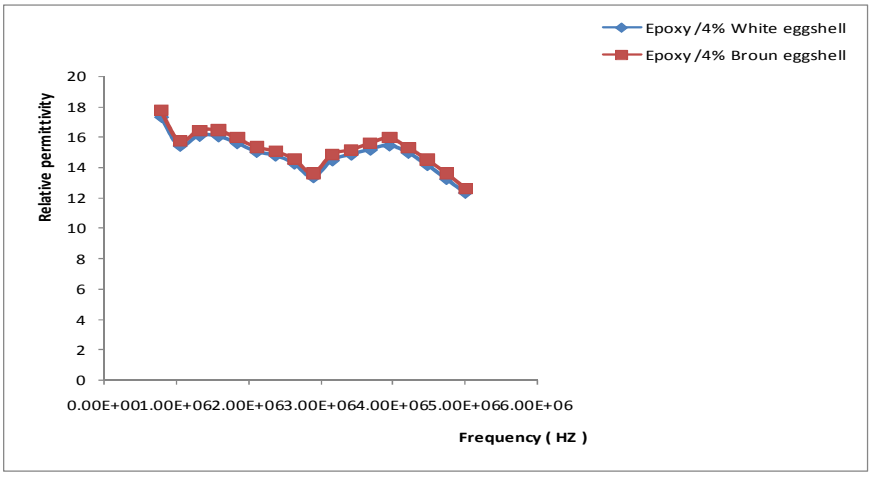

Fig.(9):Effect of kind of eggshell on relative permittivity at 4% of addition

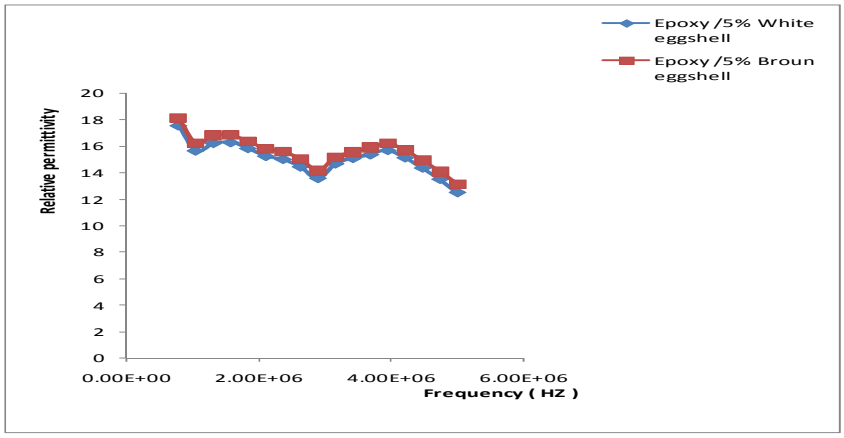

Fig. (10) : Effect of kind of eggshell on relative permittivity at 5 % of addition

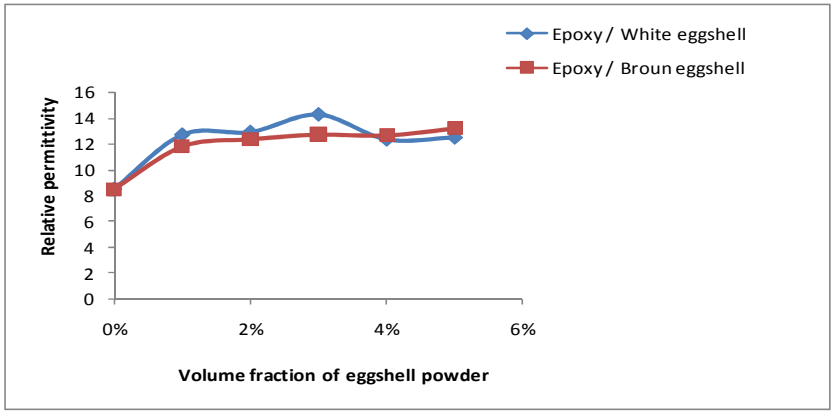

Fig.(11) : The effect of loading on relative permittivity of epoxy with white and brown eggshell powder at frequency 5 MHZ

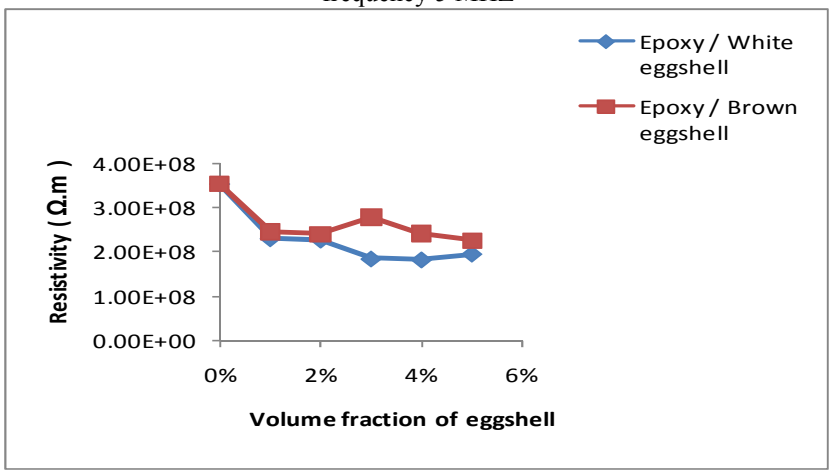

Fig. (12) : The effect of loading on the resistively of epoxy with white and brown eggshell

4. CONCLUSION

The relative permittivity values of epoxy / eggshell composite is more than that of neat epoxy at high frequencies ranges .

The thermal conductivity and the relative permittivity of epoxy / white eggshell powder have a higher value than that of epoxy / brown eggshell at 2% and 3% of loading respectively .

At 3% of loading the hardness and the resistivity of epoxy / brown eggshell powder is higher than that of the epoxy / white eggshell powder .

By using this experimental results , we can choose the best loading of eggshell for appropriate engineering application.

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