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Effect of Nanoparticles on E-Glass Fiber Epoxy Resin Composites

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ABSTRACT: *In the present work fabrication of composite material(E-Glass Fiber Epoxy Resin + NANO $CaCO_3$) was carried out and their tensile properties viz tensile strength, tensile strain(%),young's modulus, energy at maximum load and brihnall hardness number were found. Specimens of E-Glass Fiber Epoxy Resin) hybrid composites are prepared with four different compositions of nano-calcium carbonate ($CaCO_3$), viz., 0,3,5 and 7%.Each specimen consisting of 40%GF. The specimens are prepared by hand lay up method.. Tests are conducted on these specimens to determine the tensile strength, tensile strain, young's modulus energy at maximum load and hardness number at room temperature using universal testing machine and Brihnell hardness testing machine. The influence of the nano-$CaCO_3$ content on the mechanical properties tensile of hybrid composites was studied. It is found that the reinforcing and toughening effects of the E-Glass epoxy hybrid composites are increased by adding nano-$CaCO_3$.The tensile strength, tensile strain, young's modulus and energy at max load of these composites increased nonlinearly with the addition of the nano-$CaCO_3$.*

Keywords: *hybrid composites,Nano-$CaCo_3$, Epoxy resin, Tensile properties, hardness test, chopped strand mat E-glass fiber.*

I. INTRDUCTION

Fiber reinforced polymer composites are very widely used because of their favorable properties such as high specific tensile and compressive strength, controllable electrical conductivity, low coefficient of thermal expansion, good fatigue resistance and suitability for the production of complex shape materials. These materials have become the alternative of conventional structural materials such as steel, wood or metals in many applications. Typical areas of composite applications are car industry, aircraft fabrication, wind power plant, boats, ships, etc. During the human history, composites made occasionally large breakthroughs in construction and other materials. Among the composites, Chopped strand mat E-glass/ epoxy composite is emerging as a promising material for marine application due to their excellent superior strength, moisture resistance and electrical and fire insulation than that of other composites in making boat hulls, fiber glass boat. Bijesh1 , studied the mechanical properties of chopped strand mat E-glass / epoxy composite with different fiber wt%. He found that 50wt% fiber composite gave the high mechanical properties than that of (30 and 40wt %). They found that 5wt% nanoCaCo3 epoxy sample gave the highest tensile strength & Vickers hardness value among all remaining (0 to 8 wt %). Literature survey indicate that very limited work has been done on mechanical behavior of chopped strand mat E-glass fiber reinforced epoxy composite of varying fiber wt%. Various researchers have investigated the effect of Nano-inclusions on various polymers and also discussed the properties of polymers. The influence of adding Nano-inclusions to the polymers are studied. here the aim of this work is to fabricate the chopped strand mat E-glass / epoxy nanoCaCo3 composite of varying wt% using hand layup technique and to study the mechanical properties of the composites. Various other different methods of fabricating the polymer matrix composites are wet lay up (hand layup), resin transfer molding, filament winding and compression molding. Among the techniques mentioned above, Hand layup technique is used in this study since; it is effective, economic, good surface finish and easy fabrication.

II. EXPERIMENTAL ANALYSIS

Chopped strand mat (powder bonded) is formed by binding chopped glass fibers, using spraying powder binder. The density of the mat is 450g/m2 supplied by Binani Industries Limited (Glass Fibre Division). Initially (330x330) mm mat of four layers are cut for fabricating each composite. The fibre content in the three composites are 30 wt% of total weight of the composite. The type of epoxy resin used in the present investigation is Araldite LY556 and hardener is HY951. They are mixed in 10:1 weight ratio. The epoxy weight in the all composites are same wt% of total weight of the composite. Nano CaCo3 is added to all sheets.

Smectites have a unique morphology featuring one dimension in the nanometer range. Nonmaterial's can be defined as materials which have structured components with at least one dimension less than 100 nm.

III. COMPOSITES PREPARATION

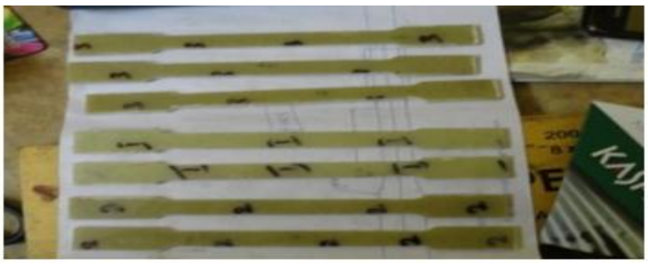
The composite material used for this study is prepared by hand lay up method as shown in below fig. Mold release agent is applied to milar sheet of 75 micron. Epoxy resin and nano CaCo3are mixed and kept for one or two hours. Then, this mixture is mixed with the hardener, and applied to the milar sheet. Then the mat is kept and final mixture is applied to the mat. Now, roller is used to eliminate air bubbles. The same procedure is carried out for all four mats for each composite. Another milar sheet is kept on this and air bubbles are removed. Then the composites so prepared are cured at room temperature for 18 hours. The post curing is carried out in sun light for 4 hours on each side of the three composites. The stoppers are used for ensuring uniform thickness for the composites. Figures 2,3 and 4 show the composites prepared for this study.

Fig: Hand layup method

Instrument and Methodology

The tensile properties of E-Glass Fiber Epoxy Resin+*NANO* $CaCO_3$ hybrid composites are measured at room temperature by means of universal testing machine with extensometer .Tests were conducted according to ASTM D638 standard with cross-head descending speed of 2mm/min. The various properties are found from the experiment are tensile strength, tensile elongation at break point, young's modulus energy at maximum load. The mean values of polymer nano composites have been noted. The hardness test of the E-Glass Fiber Epoxy Resin+*NANO* $CaCO3_3$Ternary composites were measured at room temperature by means of a Brinell hardness testing machine. Hardness test is conducted according to ASTM E 10. All Brinell tests use a carbide ball indenter.

UNIVERSAL TESTING MACHINE **SPECIMANS FOR HARDNESS TEST**



SPECIMANS FOR TENSILE TEST ASTM D638

IV. RESULTS AND DISCUSSION

This table shows the mean values of max load, tensile strength, tensile strain, young's modulus and energy at maximum load at different specimen labels.

S.NO	Specimen label s	Mean Tensile strength (MPa)	Mean Tensile strain at Break (%)	Mean value of Youngs Modulus (MPa)	Mean value of Energy at Maximum Load (J)
1	E-GF+ Epoxy Resin +0%NC	134	3.82	4091	10.90
2	E-GF+ Epoxy Resin +3%NC	146	4.04	5666	12.43
3	E-GF+ Epoxy Resin +5%NC	145	3.93	4572	12.03
4	E-GF+ Epoxy Resin +7%NC	145	3.86	4572	11.77

1. Tensile strength

Fig 1.1 shows the dependence of the tensile strength of the E-GF+ Epoxy Resin nano-$CaC0_3$ composites on the weight fraction of nano-$CaCO_3$ ($Ø_f$) particles. The value of tensile strength increased with the increase of addition of weight fraction of nano-$CaCO_3$ particles to the matrix E-GF+ Epoxy Resin. The graph varies non-linearly from base composite to the E-GF+ Epoxy Resin +7%nano-$CaCO_3$ Hybrid composite .The maximum increase of tensile strength observed when the addition of 3% of nano-$CaCO_3$ particles to matrix this increase observed as 8 compared to the base composite i.e. E-GlassFiber Epoxy nano-$CaCO_3$.

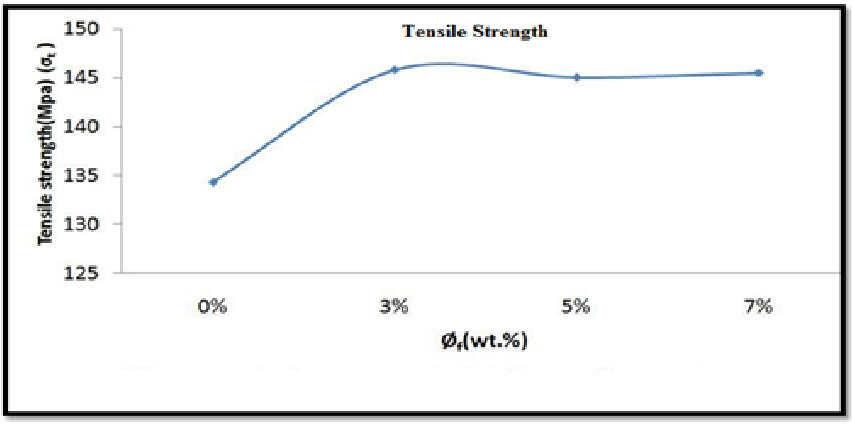


FIG 1.1 Effect of weight fraction of nano CaCO3 on tensile strength

2. Tensile strain

Fig 1.2 shows the dependence of the tensile strain of the E-GlassFiber Epoxy +Nano-$CaCO_3$ composites on the weight fraction of Nano-$CaCO_3$ particles.It can be seen that tensile strain increased non linearly with the addition of weight fraction of nano- $CaCO_3$.It means that the tensile strain of the E-GlassFiber Epoxy binary composite materials filled with the increasing nano-$CaCO_3$ concentration will be enhanced effectively. The Max increase of the tensile strain ($€_t$) is observed at $Ø_f$ =3% is 5.59% as compared to the weight fraction of nano-$CaCO_3$ at $Ø_f$ = 0%.

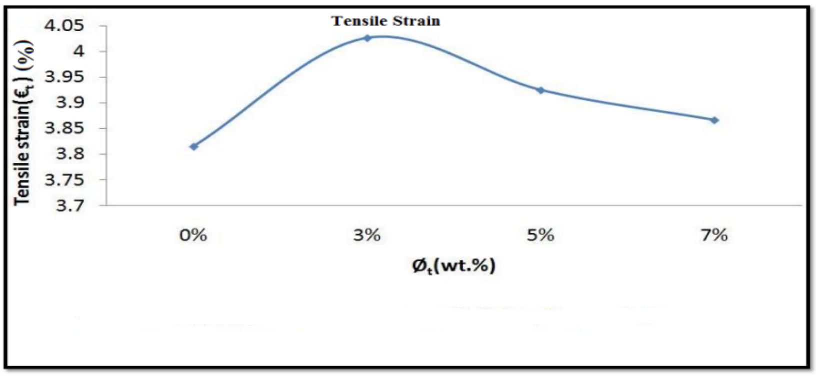


Fig 1.2: Effect of weight fraction of Nano-$CaCO_3$ ($Ø_f$) on Tensile Strain ($€_t$)

3. Young's modulus

Young's modulus is one major parameter for characterizing the tensile fracture toughness of materials. Fig 1.3 shows the effect of the weight fraction of the distribution of the particles in the matrix and the interfacial morphology between them are improved better. Consequently, the tensile fracture toughness of the E-Glass Fiber Epoxy +/nano-$CaCO_3$ hybrid composite was enhanced correspondingly. The maximum increase of the young's modulus (E_t) at $Ø_f$ =3% is 11.77% as compared to the weight fraction of nano-$CaCO_3$ at 0%.Here the young's modulus (E_t) increased non linearly up to $Ø_f$ =3% , with the addition of wt. fraction of nano-$CaCO_3$ particles then decreases up to $Ø_f$ =5% then slightly decreases up to $Ø_f$ =7%.

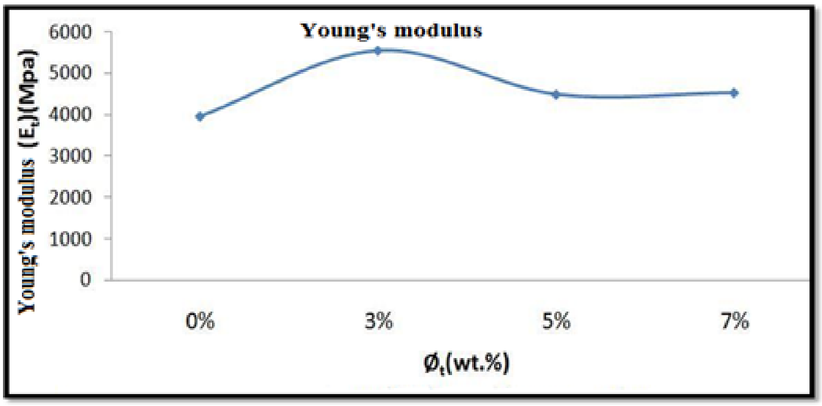


Fig 1.3: Effect of weight fraction of Nano-$CaCO_3$ ($Ø_f$) on young's modulus (E_t)

5. Hardness test results: Hardness is extensively used to characterize materials and to determine if they are suitable for their intended use. The most common uses for hardness tests is to verify the heat treatment of a part and to determine if a material has the properties necessary for its intended use. It can be seen that the maximum increase of hardness number is observed at $Ø_f$ =5% is3.14% compared to the weight fraction of nano-$CaCO_3$ at 0%. Here the hardness number increased up to $Ø_f$ =5%. With the addition of wt. fraction of nano-$CaCO_3$ particles then gradually decreases at $Ø_f$ =7%.

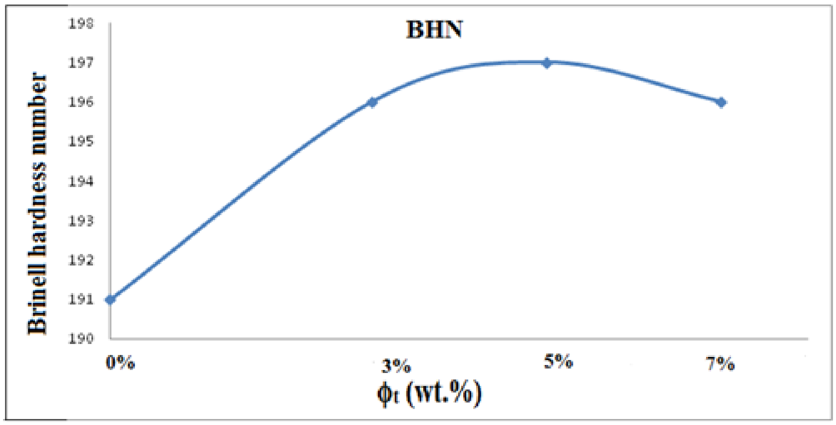


Fig.4.9 Effect of weight fraction of Nano-$CaCO_3$ ($Ø_f$) on Brinell hardness number (BHN**)**

V. CONCLUSIONS

The following conclusions are dragged from the experimental investigations

1. Reinforcing and toughening effects were found on E-GlassFiber Epoxy+nano-$CaCO_3$ composite materials.
2. It was found that when the weight fraction of the nano particles was equal to 3%, the tensile strength and young's modulus and tensile strain were increased non linearly with the weight fraction of nano-$CaCO_3$ ($Ø_f$).
3. The maximum increase of tensile strength observed when the addition of 3% of nano-$CaCO_3$ particles to matrix this increase observed as 8.78% compared to the base composite i.e., E-Glass Fiber Epoxy +nano-$CaCO_3$.
4. The maximum increase of the tensile strain ($€_t$) is observed at $Ø_f$ =3% is 5.59% compared to the weight fraction of nano-$CaCo_3$ at $Ø_f$ = 0%.
5. The maximum increase of the Young's Modulus (E_t) at $Ø_f$ =3% is 11.77% compared with the weight fraction of nano-$CaCO_3$ at 0%.Here the Young's Modulus (E_t) has been increased non linearly up to $Ø_f$

=3% with the addition of weight fraction of nano-$CaCO_3$ particles then decreases up to $Ø_f$ =5% then slightly decreases up to $Ø_f$ =7%.

6. The energy at maximum load (σ_E) is increased non linearly up to $Ø_f$=3%, with the addition of weight fraction of nano-$CaCO_3$ particles then gradually decreases up to $Ø_f$ =7%
7. It can be seen that the maximum increase of hardness number is observed at $Ø_f$ =5% is3.14% compared to the weight fraction of nano-$CaCO_3$ at 0%. Here the hardness number increased up to $Ø_f$ =5%, with the addition of wt. fraction of nano-$CaCO_3$ particles then gradually decreases at $Ø_f$ =7%.
8. The mechanical properties of tensile strength, tensile strain and young's modulus at 3% and hardness at 5% showed that there was a good.

REFERENCES

[1] Liang. and Li., "Mechanical Properties and Morphology of Glass Bead-Filled Polypropylene Composites, polymer composites" polymer composites,Vol.19 No. 6 December 1998.

[2] Ji-Zhao Lianga, Lia., "Brittle-ductile transition in polypropylene filled with glass blends" Elsevier polymer PP-3191-3195,1998.

[3] Kong Yang, Chaoyuan Wang, Jie Wei,"A study on biocomposite of nano apatite/poly(1,4-phenylene-sulfide)-poly (2,4-phenylene sulfide acid) science direct Composites: Part B 38,PP-306-310, 1st November 2006.

[4] Zhaobin Chen, Xujun Liu, Renguo Lu , Tongsheng Li,"Friction and Wear Mechanisms of PA66/PPS blend reinforced with Carbon Fiber " Wiley Inter Science, DOI 10.1002/app.25999, 28thMarch 2007.

[5] Shimpi, Verma and Mishra, "Dispersion of nano $CaCO_3$ on PVC and its Influence on Mechanical and Thermal propetie" Journal of Composite Materials 2010 vol.44: 211 17th August 2009.

[6] Shimpi, Verma and Mishra, "Dispersion of nano $CaCO_3$ on PVC and its Influence on Mechanical and Thermal propetie" Journal of Composite Materials 2010 vol.44: 211 17th August 2009.

[7] Dan Lu, Shiwei Pan,"Effects of Ball Milling Dispersion of Nano-SiOx Particles on Impact Strength and Crystallization Behavior of nano-SiOx–poly(phenylene sulfide) Nanocomposites" Wiley InterScience,DOI 10.1002/pen.20547,2006.

[8] Knor,Walter,Haupert,"Mechanical and Thermal Properties of Nano-Titanium Dioxide-Reinforced Polyetheretherketone Produced by Optimized Twin Screw Extrusion" Journal of Thermoplastic Composite Materials 2011 vol.24: 185 ,2010.

[9] Rajendra Kumar Goyal and Amol Kadam, "Polyphenylene sulphide/graphite composites for EMI shielding applications" VBRI press Adv. Mat. Lett. 2010, 1(2), PP-143-147,27 July 2010.

[10] Hanim,Ahmad Fuad, Zarina, Mohd Ishak and Azman Hassa, "Properties and Structure of Polypropylene/ Polyethylene-Octene elastomer/nano $CaCO_3$ Composites" Journal of Thermoplastic Composite Materials vol.21: 123,2008.

[11] Qiyang, Limin, Guangxin and You"Preparation and Characterization of Acrylic/Nano-TiO2 Composite Latex High Performance Polymers"High Performance Polymers vol.14: 383,2002.