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MECHANICAL PROPERTIES CHARACTERIZATION OF SiC AND KEVLAR FIBER REINFORCED EPOXY HYBRID COMPOSITES

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Abstract : In this paper an attempt has been made to prepare the hybrid composites by using different weight percentages :1wt%, 2 wt% and 3 wt% of Nano silica in epoxy composites with different ratio of Kevlar fiber in epoxy resin and a study on the mechanical property of the samples was done.

Key words: Nano Silica, Polymer, Epoxy, Mechanical Properties, Composites

1 Introduction

From the past various decades attempts have been made to improve the properties of polymer blends by reinforcing the material with suitable fillers. The made material with the support in the polymer organize show improved mechanical properties occurring because of complex connection of properties of the constituents. . The essential limits which are based on are volume level of filler, filler extent, particle size, state of filler, inborn properties of constituents and so forth [1-6].It has been accounted for that expanding the surface region and filler substance prompts an improvement in the effect properties and mechanical properties [7,8]. Be that as it may, during the arrangement of composites a few endeavors are made to expand the similarity between hydrophobic natural framework and inorganic fillers.

Because of the restricted properties of natural materials, these materials linger behind in the use for elite applications. So just, advancement of natural/inorganic composites occurred. So as to improve the properties of epoxy a material having better property has than be added to balance; one such material is silicon carbide. Epoxy has high coefficient of warm development and lower mechanical properties, so it can't be applied legitimately on auxiliary applications. Adding support in epoxy assists with improving its properties. One significant job that fortification plays is to move the heap to framework however this is conceivable just if there is a decent

interface communication between the grid and the support. There are numerous fortifications that can be added to polymers for the upgrade of properties like glass particles, clay particles, layered silicates, metal particles and thermoplastics. Now and again artistic nano particles, earth, graphene and CNT are additionally added to harden the epoxy sap by plastic void development, split sticking and so on., with a synchronous increment in quality, and modulus and with no exceptional impact on glass change temperature. In the event that fillers included bigger weight rate, at that point an observable improvement in durability of epoxy grid will likewise be seen.

Epoxy and its composites are generally utilized in coatings, preparing, glues, epitome of semiconductors, laminations and so on [9-11]. Adding silicon carbide to epoxy lattice empowers lower shrinkage on relieving, improvement in different mechanical properties. Consolidation of all around scattered inorganic particles in a polymer framework has end up being viable in improving execution of polymer network composites [11, 12]. Without a uniform scattering, particles would will in general agglomerate and cause molecule to-molecule instead of the planned molecule to-polymer collaboration and in the long run bring about the corruption of properties [13-15]. Including of silicon carbide particles prompts an improvement in mechanical electrical and warm properties [15]. Epoxy and its composites are commonly used in coatings, getting ready, concretes, encapsulation of semiconductors, covers and so forth [16]. Adding silicon carbide to epoxy arrange enables lower shrinkage on reestablishing, improvement in various mechanical properties. Circuit of all around dissipated inorganic particles in a polymer cross section have wind up being incredible in improving execution of polymer structure composites [17, 18]. Including silicon carbide particles prompts an improvement in mechanical electrical and warm properties [18]. Silicon carbide/epoxy composite material is a comprehensively used material in light of their ability to help mechanical similarly as tender stacking. Reinforcing silicon carbide particles prompts an improvement in mechanical electrical and thermal properties [18]. Silicon carbide/epoxy composite material is a broadly utilized matter because of their capacity to support mechanical just as affectionate loading.

2 Materials and Methods

2.1 Preparation of Epoxy and SiC nano particles

In the present research polymeric composites were prepared by 1wt%, 2 wt% and 3 wt% of SiC is included and epoxy was taken 150gm.

Pretreatment of nano SiC and Epoxy Polymer So as to eliminate the consumed dampness nano SiC particles in the fine particles structure is preheated in the furnace at 110°C for 90min. prior heating of silicon carbide particles decreases the odds of agglomerations because of the existence of dampness. As epoxy is having more viscosity, consequently can't be mixed effectively by magnetic stirrer, so an underlying heating of epoxy is carried out . For, this epoxy is warm to 75°C to lessen its viscosity.

To shape a uniform mix of SiC and Epoxy, magnetic stirrer is used. Epoxy was kept on the magnetic stirrer and gradually in limited quantities wanted weight percent of silica particles are added to the epoxy resin and afterward magnetic bead is set to turn at 600rpm for 90min at 75°C, which can be trailed by mechanical blending of the blend utilizing a stirrer with four edges slanted at 45° with the pivot of shaft. Blending is accomplished for 30min with a steady speed up till 400rpm as a result an appropriate composition is framed so a uniform scattering happens. When the blend spans to the ambient temperature, hardener (HY-951) is blended in the proportion of 15:1, for example in 150gm of epoxy 10gm of hardener is included. As the response subsequent to including the hardener is exothermic it discharges warmth and starts getting hard in next 10 to 15min.Dies were coated with wax applied on the internal surfaces for easy removal of the samples.

Fig.1- Lower and Upper part of Shoulder Die and Lower and Upper part of Plate Die.

Fig.2 - Shoulder and Plate die with material filled in it.

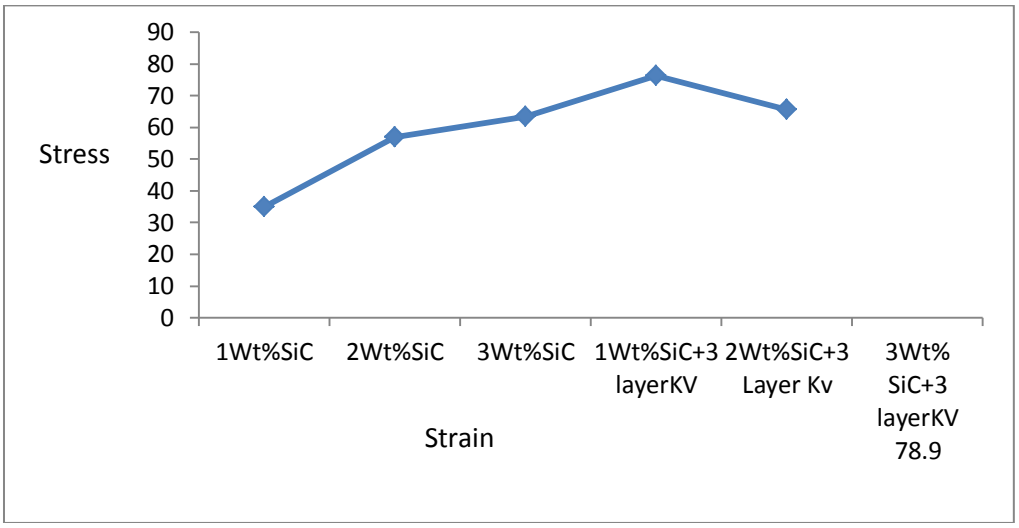
After addition of hardener the mix of about 70gm weight was taken, one coating of epoxy resin and SiC mix is extend on the base of plate die, and then a layer of Kevlar fiber mat is kept back follow by pressing it consistently by using hand roller to remove any air gaps. The same procedure is adopted for the second and third layer of Kevlar fiber mat. Finally a hybrid composite plate sample is ready having epoxy and SiC mixture and 2 layers of Kevlar fiber mat .The plate test is then cut in the ideal measurements as indicated by ASTM norms with the fiber cutting machine.

3 Result and Discussion

Flexural test are the tests where all the three stress namely compressive, shear and tensile acts on the specimen and results is a combined outcome of all the three. The outermost fiber that forms the convex surface bears the tensile stress while the inner fiber is subjected to compressive stress, and the mid plane has shear stress. To investigate whether the failure is from tensile or compressive stress the effect of shear stress has to be minimized. And this minimization of shear stress is done by controlling span to depth ratio which is usually kept.

The flexural testing was conducted on an INSTRON-3382 machine, at Regional engineering college (NIT ROURKELA). The flexural test samples were developed according to ASTM D790 flexural sample requirement for polymer and plastic materials.

Flexural test result is shown below –



From these graphs it can be concluded that the mixing of nano silica has productively improved the tensile strength and elongation at break of the nanosilica-filled epoxy composites. Enhancement of flexural strength by adding up of SiC particles in to the epoxy resin was due to two reasons. (i) Youngs modulus of the SiC particales is superior to that of the epoxy resin and therefore stress transfer from the medium to the particles occurred. Consequently, the strength of the samples increased. (ii) Inclusion of SiC particles in epoxy composites enhance the interfacial bonding among the Kevlar fiber and epoxy resin.

4 Conclusions

Epoxy/ Nano SiC nano-composite and Epoxy/ Nano SiC + Kevlar Fiber Hybrid Composite have been fabricated successfully using hand lay-up technique.

Ultra -sonication process was used for distribution of nano particles in the epoxy resin at suitable rpm.

Properties are enhanced by many folds when epoxy and nano SiC polymer matrix composite is reinforced with 3 layers of Kevlar fiber, thus forming a hybrid composite.

Rise in the tensile properties with increment in wt % of SiC occurred, in both polymeric matrix composites.

Enhancement in the flexural properties with increase in wt% of SiC till 2 wt% then it decreases for 3 wt%. It is noted for both the polymer matrix composite and also for the 3 layer kevlar fiber reinforced epoxy composites.

References

1. Donnet, J.B.: Nano and microcomposites of polymers elastomers and their reinforcement. Composites Science and Technology, (63), 1085-1088, (2008).
2. Poornima, V. P., Debora, P., Agnieszka, D., Pournami, V. P., Andrzej, Huczko , Jose M Kenny and Sabu Thomas (2014) Mechanical and thermal properties of epoxy/silicon carbide nanofiber composites. Polymers for Advanced Technologies, (wileyonlinelibrary.com) DOI: 10.1002/pat.3437.
3. Day RJ, Lovell PA, Wazzan AA, (2001) Toughened carbon/epoxy composites made by using core/shell particles. Composites Science and Technology, 61:41–56.
4. Bagher R, Pearson RA (2000)Role of particle cavitation in rubber-toughened epoxies: II. Inter-particle distance Polymer, 41 : 269-276.
5. Takafumi Kawaguchi, Raymond A Pearson, (2003) The effect of particle–matrix adhesion on the mechanical behavior of glass filled epoxies. Part 2. A study on fracture toughness, Polymer 44: 4239-4247.
6. Hassan Mahfuza, Ashfaq Adnan, Vijaya K. Rangari, Shaik Jeelani, Bor Z. Jang, (2004) Carbon nanoparticles/whiskers reinforced composites and their tensile response, Composites Part A: Applied Science and Manufacturing, 35: 519–527.
7. V.M.F.Evora, Shukla A, (2003) Mater.Sci.Eng., A361: 358-368.
8. Hussain M, Oku Y, Nakahira A, Niihara K(1996) Mater. Lett, 26 :177.
9. Schmidt D, Shah D, Giannelis E, (2002) Curr. Opin. Solid State Mater. Sci., 6 : 205-208.
10. Redhwi H H ,Siddiqui, M N Andrady A L and. Hussain S (2013)Durability of LDPE nanocomposites with clay, silica, and zinc oxide: part I: mechanical properties of the nanocomposite materials Journal of Nanomaterials, 2013:1- 6
11. Mahfuz H,. Islam M S, Rangari VK, Saha M C, Jeelani S (2004) Compos. Part B: Eng.,35: 543.
12. Mahfuz H, Rangari V K, Islalm M S, Jeelani S (2004) Compos.Part A: Appl. Sci. Manuf,35: 453.
13. T. Kawaguchi, R. A. Pearson (2003)Polymer 44: 4229
14. Bhagyashekar M S, Rao RMVGK Rao(2007) Effects of Material and Test Parameters on the Wear Behavior of Particulate Filled Composites Part 1: SiC-Epoxy and Gr-Epoxy Composites, Journal of Reinforced Plastics and Composites 26: 1753.

15. Amal Nassar, Eman Nassar (2014)Thermo and Mechanical Properties of Fine Silicon Carbide /Chopped Carbon Fiber Reinforced Epoxy Composites, Universal Journal of Mechanical Engineering 2: 287-292.
16. Zhang J Xu Y C, Huang P, (2009) Effect of cure cycle on curing process and hardnes for epoxy resin, *e*XPRESS Polymer Letters.3: 534–541.
17. Yaping Zhenga, Ying Zhengb, Rongchang Ning (2003) Effects of nanoparticles SiO2 on the performance of nanocomposite, Materials Letters, 57: 2940 – 2944.
18. Song GJ (1996) Polymeric nano-metered composites Mater. Rep. 4 57 – 60.
19. Author, F.: Article title. Journal 2(5), 99–110 (2016).
20. Author, F., Author, S.: Title of a proceedings paper. In: Editor, F., Editor, S. (eds.) CONFERENCE 2016, LNCS, vol. 9999, pp. 1–13. Springer, Heidelberg (2016).
21. Author, F., Author, S., Author, T.: Book title. 2nd edn. Publisher, Location (1999).
22. Author, F.: Contribution title. In: 9th International Proceedings on Proceedings, pp. 1–2. Publisher, Location (2010).
23. LNCS Homepage, http://www.springer.com/lncs, last accessed 2016/11/21.