Effect of ZnO Nanocomposite by Direct and In Direct Sonication Method

S . Manigandan
Lecturer, Department of aeronautical
Sathyabama University
Chennai, India
Manisek87@gmail.com

P . Gunasekar
Lecturer, Department of aeronautical
Sathyabama University
Chennai, India
konguguna@gmail.com

J . Devipriya
Lecturer, Department of aeronautical
Sathyabama University
Chennai, India
jdevipriya16@gmail.com

S . AmalRaj
Student, Department of aeronautical
Sathyabama University
Chennai, India
amalrajrm96@gmail.com

***Abstract*—** The zinc oxide well known for its dielectric property and the anticorrosion, widely used in solar cells. This section deals about the development of the both mechanical and electrical property of Kevlar by adding the ZnO nano composites inside vinyl ester resin. The zinc oxide mixed well with the polyvinyl ester resin without disturbing the chemical behavior of the ZnO. The synthesis of zinc oxide with polyvinyl ester resin done by the direct and indirect sonication process. The kevlar fiber taken as the specimen for this research. The ZnO – polyvinyl ester resin mixed together using the manual without affecting the hydrophobic behavior of the polyvinyl ester resin, the zinc oxide and polyvinyl ester resin mixed with hardener (HY956) with the standard ratio of 5:1. The size of zinc oxide is 75nm. The results show that the direct sonication process giving better tribological properties when compared to indirect sonication process. From the plot and tables it is understood that the kevlar performs superior with ZnO nanocomposites.

Keywords: *Zinc Oxide, Anticorrosion, Direct mixing method, Non covalent approach, Hydrophobic.*

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I. INTRODUCTION

The Zinc Oxide (ZnO) is inorganic semi-conducting material and its has a wide applications due to photochemical properties and electrical conductivity of the zinc oxide. The review papers shows that when the ZnO mixed with vinyl ester by direct sonication process the electrical conductivity and dielectric property of composite is improved significantly. The Kevlar is taken for this research since they have good mechanical properties and better impact resistance [4, 7].

The effect of nanocomposites on the structure of the composites is still a major study, since during reinforcement the internal structure of the fiber may be affected. The size of zinc oxide taken to study is 60nm diameter. The study is made on ZnO, ZrO2 and CeO2 nanometal oxide to understand the mechanical stability [1]. The anticorrosion performance also studied with the help of paper [3]. The specimen is tested for stress-strain relationship under compression as well as tensile. The results are tabulated and they are evaluated with computational results.

Many attempts have been reported recently on studying tropological properties of polymer composites by using mechanical stirring, manual stirring and sonication processes

II. METHODS OF SONICATION

These methods are;

(i) Mechanical stirring (at 200 rpm) during the stage of mixing at the temperature of 50 C for 2 h followed by sonication. Constantly, degassed at 100 C by pre-curing at 150 C for 5 h and post-curing at 180 C for 1 h;

(ii) Mixing progression was performed at the temperature 30 C and 60 C followed by sonication for 3–6 h. Hardener is added afterwards [9].

(iii) Magnetic stirring (with a magnetic bar) followed by high shear mixer and sonication during the stage of at room temperature by vacuum curing at the temperature of 75 C for 3h.

(iv) The manual stirring also done by direct mixing method at the temperature of 50 C

III. EXPERIMENTAL SETUP

The vinyl ester is treated with the ZnO and they reinforced with the Kevlar fiber when compression mouliding process to improve the stability of curing. After curing 22hour the specimen is taken and it is tested for the topological properties. The ZnO is synthesis can be done by several methods, this paper deals about solution mixing method. The solution of zinc sulfate which is in aqueous form added slowly with sodium hydroxide solution in a molar ratio of 1:2 under forceful stirring at 200 rpm and the stirring was continuous for 10-12 h. The precipitate obtained from the stirring was filtered and washed with deionized water. After the washing them thoroughly precipitate was dried at 100°C and ground to fine

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powder using agate mortar [7]. The obtained powder was calcined at different temperatures such as 300°C, 500°C, 700°C, and 900°C for 2 h. the prepared ZnO is mixed with the vinyl ester to form matrix.

IV. RESULTS AND DISCUSSION

Two types of specimen is taken for the study, the specimen 1 preapred by the direct sonication process and the specimen 2 is prepared by the indirect sonication process. The reinforced specimen is tested separetly to find there mechanical behavior of them.The results is derived and the dats are compared to find this covalent approach giving better property.

TABLE I. TENSILE PROPERTY OF THE KEVLAR-ZNO

Contents	Kevlar-vinyl ester		
	Kevlar	*K-ZnO (Direct sonication)*	*K-ZnO (Indirect sonication)*
Ultimate/ Break Load (KN)	14.4	17.42	14.5
Disp at Fmax(mm)	13.7	16.58	13.8
Max.Disp(mm)	15.3	18.51	15.5
Area mm²	60.7	73.45	47.4
Ult.Stress(Mpa)	249	301.29	251.5
Yield stress (Mpa)	140	169.40	141.4
YS/UTS Ratio	0.5	0.61	0.5
Elongation	0.28	0.34	0.3

TABLE II. COMPRESSION PROPERTY OF THE KEVLAR-ZNO

Contents	Kevlar-vinyl ester		
	Kevlar	*K-ZnO (Direct sonication)*	*K-ZnO (Indirect sonication)*
Ult/Break Load	0.7	1.015	0.95
Disp at Fmax(mm)	3	4.35	4.6
Max.Disp(mm)	10.2	14.79	14
Ult.Stress	12	17.4	13.5

The table 1 and table 2 show the mechanical property of the Kevlar and the Kevlar ZnO nanocomposites by both direct and indirect sonication process. The above table shows that the property of fiber is improved in direct sonication process.

The property like ultimate stress is improved early 25% when the direct sonication method is practiced. The results of both compression and tensile is further can be validated with the computational results. The computational results are derived from the FEM tool. The validation is done to predict the accuracy of the experimental results [6].

TABLE III. ULTIMATE STRENGTH BY DIRECT SONICATION PROCESS

sample	*Ultimate strength*	*%of improvement*
Vinyl ester	42.4	0
5% ZnO inside vinyl ester	48	11.3
10% ZnO inside vinyl ester	52	10.8
13% ZnO inside vinyl ester	56	10.8
18% ZnO inside vinyl ester	62	11.1
25% ZnO inside vinyl ester	58	9.4
30% ZnO inside vinyl ester	53	9.1

TABLE III. ULTIMATE STRENGTH BY INDIRECT SONICATION PROCESS

sample	*Ultimate strength*	*%of improvement*
Vinyl ester	42.4	0
5% ZnO inside vinyl ester	44.16	8.48
10% ZnO inside vinyl ester	47.84	9.18
13% ZnO inside vinyl ester	51.52	9.89
18% ZnO inside vinyl ester	57.04	10.95
25% ZnO inside vinyl ester	53.36	10.24
30% ZnO inside vinyl ester	48.76	9.36

The table 3 and table 4 depicts that when the ZnO level increases the strength of the fiber increased significantly however if the level goes beyond threshold the ultimate strength of the fiber starts to decline rapidly.

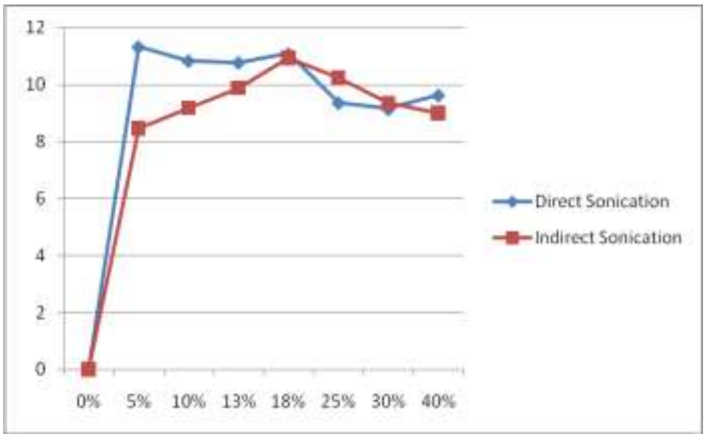

Fig 1. % of Improvement in ultimate strength plot

The above plot shows that the direct sonication synthesis is better ultimate strength when compared to the indirect sonication process.

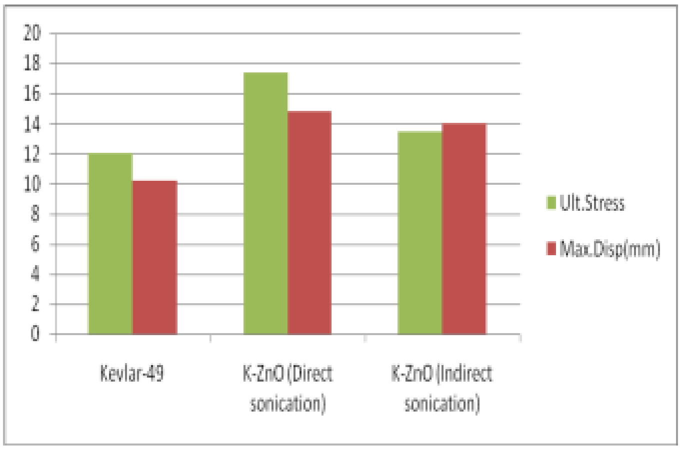

Fig. 2. The stress and starin relationship

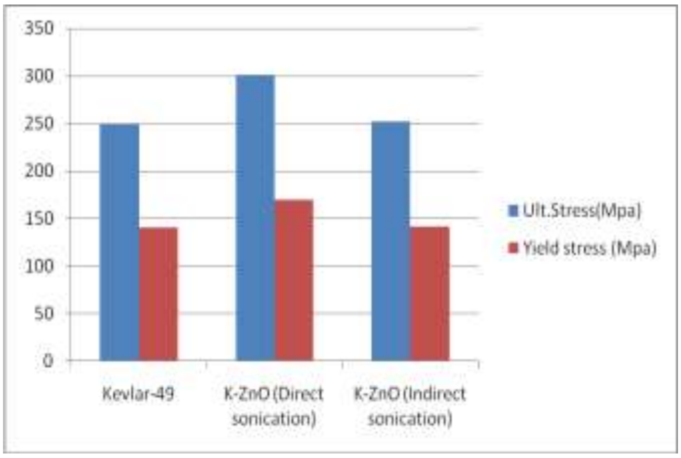

Fig. 3. The ultimate stress vs yield stress

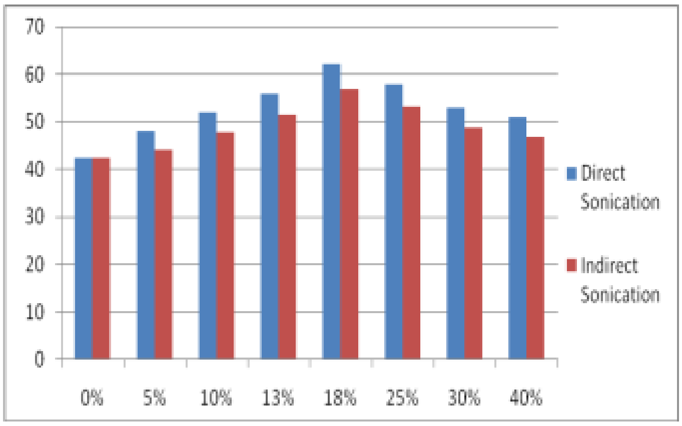

Fig. 4. % of improvement in ultimate strength

The figure 2,3and 4 shows the effect of the sonication process. The results are compared with the [9,8], it shows that the percentage of augmentation is acceptable limit.

V. Conclusion

The specimen tested for the mechanical properties by standard, direct sonication and indirect sonication process. The result shows that the mechanical property of the Kevlar is increased up to 25% when filled with ZnO. The results also predicted that the mechanical property of the nanocomposite fiber is depending on the process of synthesis.

The ultimate strength of the fiber is increased when the direct soncation process is applied rather than the indirect sonication process.

The results also proves as the level of the zinc oxide content increases the strength of the fiber also increases however after 40% ZnO content with vinyl ester the strength is dropping rapidly.

It is evident that the strength of the fiber is better when 18% of ZnO content is mixed with the vinyl ester.

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