EFFECT OF DISPERSED XD-CNTS ON THE THERMAL PROPERTIES OF EPON 862-W RESIN

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INTRODUCTION

This paper presents the development of a novel resin system for multifunctional applications that require thermal and electrical conductivity, self-sensing and self-actuation capabilities without a loss of required mechanical properties[1]. In particular paper addresses fabrication and characterization of XD-CNTs reinforced epoxy towards the development resin system with improved thermal properties. The study presents effect of nanoconstituents dispersed into the resin as reinforcements on the thermal properties of resin. In the present study six different weight percentages of XD-CNTs ranging from 0.015% to 5 % were investigated. The study indicates that, there was an improvement of upto 16% in thermal property of the epoxy resin, when resin was dispersed with 1w% XD-CNTs.

FABRICATION OF RESIN COUPONS WITH VARIOUS PERCENTAGES OF XD-CNT'S

Six different sets of test coupons were fabricated to determine the effects of XD-CNTs on the thermal conductivity of the Epon 862-W resin system. The test sets consisted of one set of neat resin specimens. The remaining sets were manufactured in the following manner. XD-CNTs were weighed with the following percentages by weight compared to the 862-W resin weight: 0.015%, 0.150%, 0.5%, 1.0% and 5.0%. It was determined that when percentages were greater than 3.0% XD-CNTs, the mixture became clumpy and did not produce well dispersed resin mixture specimens. Therefore, the 5.0% specimens did not produce good results and are not included in this study. Resin Epon 862 and W catalyst is typically mixed with the ratio of 862 resin:W catalyst (100g:26.4g). The XD-CNTs measured and mixed into the 862 resin. The combination was placed into an oven and heated @ 110°F for 30 minutes to reduce viscosity. The mixture was then sonicated for 3 hours at 30% power with a pulse of 3 seconds on-3seconds off. Examination of earlier sonicated mixture found damage CNT's, so the level of power was reduced to protect the CNT's structure. Pulsing was performed to reduce the generation of heat in the mixture. During sonication, to remove heat, the beaker with the mixture was placed into a water bath as shown in Figure 1a.

Since sonication of the mixture generates heat thus reducing the viscosity, it was possible to directly pour and mix the W catalyst into first mixture. The new combination of 862-W-XDCNTs was then sonicated for 30 minutes. The mixture was then poured into three previously prepared 30ml syringes, leaving space for air to escape at top. The syringes were placed into a rack (see Figure 1b.) and placed into oven for 2 hours @ 250°F. Next, the syringes were cut from the semi-cured mixture, then placed back into an oven and finished curing for another 2 hours @ 350°F. The final rods can be seen in Figure 2a.

Three one-half inch thick specimens were cut from the top, middle and bottom of each type rod. This was done as a check to determine the homogeneity of the mixture. Figure 2b illustrates neat resin and XDCNT mixture test buttons.

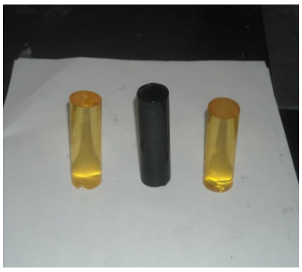
THERMAL CONDUCTIVITY TESTING

Thermtest Model TPS2500S Thermal Conductivity Test System was used to test the thermal conductivity of the specimens.

a. b.

Fig.1a. Material being sonicated,

Fig.1b. Sonicated Resin/XDCNT mixture



a. b.

Fig. 2a. Cured resin columns.

Fig. 2b. Specimens cut for testing.

The TPS system operates on the principle of placing a thin TPS (Transient Plane Source) sensor (Figure 3.) between two pieces of the object or material being tested. Figure 4 is an actual photograph of a test being performed. The plane sensor consists of a Nickel double spiral (10 μm thick) sandwiched between two thin electrically insulating sheets of material. This insulating material is a polyimide (Kapton) for temperatures from 30 K to 450 K and a Mica material from 450 K to 1000 K. During transient recording, the sensor is electrically heated and at the same time the resistance or the temperature increase of the Nickel double spiral is monitored.

The heat generated in the sensor dissipates in all directions into the surrounding two sample pieces. The test process was conducted on each of the six percentage combinations, the values were averaged and their standard deviation was calculated for each set and placed in the Table 1.

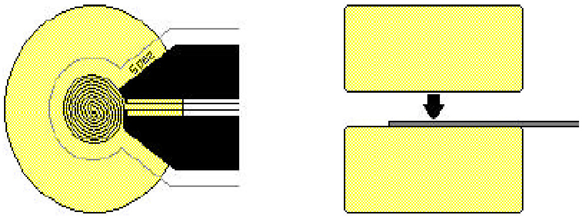


Fig. 3 Schematic of thermal sensor setup

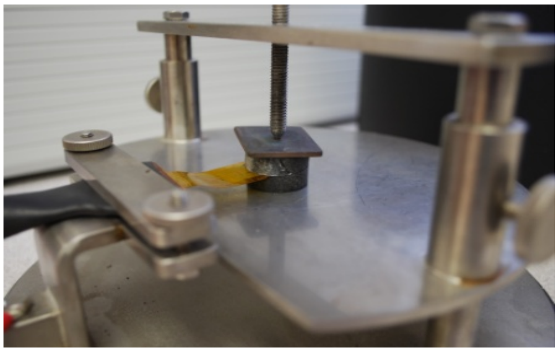


Fig. 4 Thermal Conductivity test setup.

Table 1 Mean thermal conductivity values

Sample	AVG Thermal Conductivity (W/mK)	Standard Deviation (W/mK)
0.000%	0.2386	0.0008
0.015%	0.2391	0.0020
0.150%	0.2394	0.0007
0.500% Top	0.2577	0.0021
0.500% Bottom	0.2610	0.0007
1.000% Top	0.2777	0.0012
1.000% Bottom	0.2760	0.0012

CONCLUSION

The present study indicates that the thermal conductivity was improved upto 16% when XDCNTs one percent by weigh were added to Epon 862-W resin system.

REFERENCES

1. M. J. Schulz, A. D. Kelkar, and M. J. Sundaresan, “Nanoengineering of Structural, Functional and Smart Materials,” Taylor & Francis, Boca Raton, (2006), Pg. 469 – 498.