Preparation of General Purpose Unsaturated Polyester/ ZnO Nano Composites and their characterization

G. Ramesh, K. Rajeswari and S. Guhanathan*
PG & Research Department of Chemistry
Muthurangam Govt. Arts College (Autonomous)
Vellore- 632 002
***Email: sai_gugan@yahoo.com**

Abstract: **Nano composites were prepared by blending General Purpose Unsaturated polyester resin with ZnO nanoparticles of various weight percentages. They were characterized by various analytical techniques such as FTIR, SEM, and TGA-DTA. Measurement of mechanical properties like Tensile strength, impact strength, flexural Strength and hardness were carried out and physical properties like water absorption, density, specific gravity, etc. were also carried out. The effect of particle size, particle distribution on mechanical properties, thermal properties and physical properties were studied. The changes in the properties of the composites were studied.**
Keywords: polyester resin-Zinc oxide nano particles -mechanical properties -Surface treatment- Thermal properties.

I. INTRODUCTION

Nanotechnology and nanoscience got started in the early 1980s with two major developments; the birth of cluster science and the invention of the scanning tunneling microscope (STM). This development led to the discovery of fullerenes in 1986 and carbon nanotubes a few years later. In another development, the synthesis and properties of semiconductor nanocrystals was studied. This led to a fast increasing number of metal oxide nanoparticles of quantum dots. Polymer with nano fillers based nanocomposites have received considerable attention since the discovery made by Toyota researcher that polymer properties can be greatly improved by the presence of nanosized clay particles [1,2]. Long chain alkyl ammonium exchanged forms of montmorillonite are mostly used for nanocomposite preparation. Lot of research works have been carried out in different polymer systems like epoxy [3], polyesteramide [4], polyimide [5], polyurethane [6] and polypropylene [7]. Based on the careful analysis of literature present investigation aimed to satisfy the general purpose unsaturated polyester resin with metal nanoparticles like ZnO nanoparticles on spectral and thermal properties in addition to mechanical properties.

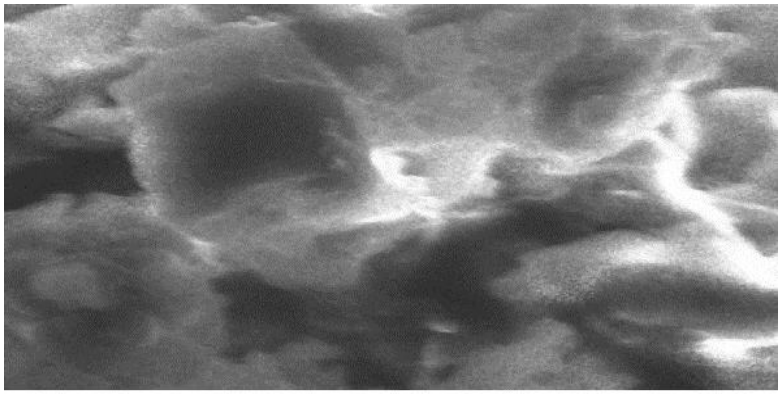
II. Experimental

Preparation of polyester composite and nano composite:

The unsaturated polyester was purchased from Shakti fiber glass limited, Chennai. At every trial of the process 210 ml of polyester was optimally required to fill the mould to its capacity. In addition to this 2 ml of cobalt napthanate and 2 ml of methyl ethyl ketone peroxide were used as hardener and accelerating agent respectively. To the 210 ml of polyester the 2 ml of cobalt napthanate was added initially and stirred until the purple colour of the hardener was completely dispersed in the polyester solution. At such time the 2 ml of methyl ethyl ketone peroxide was added and stirred thoroughly following which the solution was immediately poured in to the mould. Similar procedure have adopted with metal nanoparticles and cast into the sheets. Facbricated nanocomposite were cut into the specific dimensions with respect to American Standard for Testing Materials (ASTM) for tensile, flexural, impact and hardness studies.

FT-IR analysis was performed on Nicolet Avatar 330 Spectrometer with KBr pellets for solid specimens FT-IR spectra of 100% polyester, which exhibits characteristic strong absorption peaks at 2925 cm-1, 1728 cm-1 3435 cm-1 due to aliphatic C-H, C=O and O-H Stretching's respectively. It showed peak such as terminal O-H group, aliphatic C-H and Carbonyl group around 3430, 2925, 1728 cm-1 respectively.

Scanning Electron Microscope (SEM) was used to study the nanoparticles dispersion, and voids present in matrix. Incorporation of nanoparticles was clearly pointed out by SEM analysis (Figure1 & 2).



SEM IMAGE OF PURE POLYESTER

Figure.1 SEM Image of pure polyester

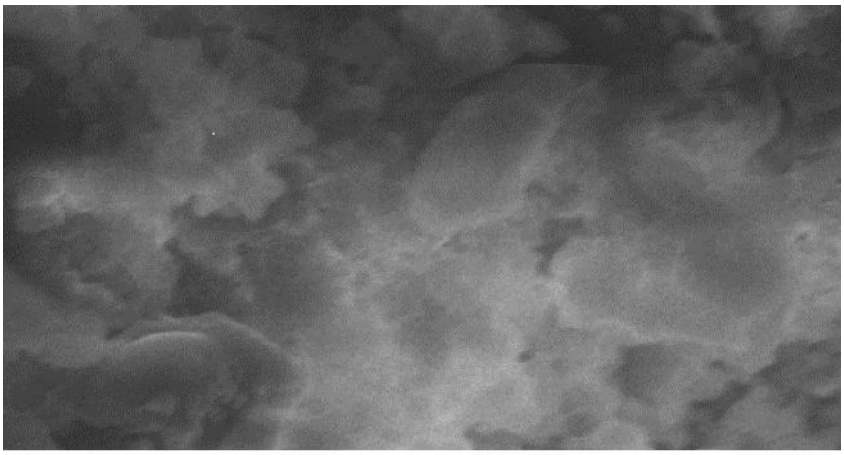


Figure.2 SEM of Polyester-ZnO nanoparticles

Table .1 Report of mechanical Studies of Zinc Oxide- GPR Nanocomposites

Sample Code	Tensile Strength (MPa) ASTM D 638	Impact Strength (KJ/m^2) ASTM D 256	Flexural Strength (MPa)ASTM D 790
GPNO – 00 (Plain)	42.16	3.84	75.05
GPNO –05 (0.5 %)	34.08	1.80	72.29
GPNO –10 (1.0%)	32.78	1.79	71.65
GPNO –15 (1.5%)	28.13	2.79	66.28

Table 1. Summarised the mechanical properties of Zinc -oxide polyester nano composite. According to the table plain polyester has excellent tensile, impact and flexural strength than that of 0.5%, 10% and 15% loaded ZnO nanoparticles. The results might be due to the poor interfacial bond has been created by ZnO with polyester.

III. Thermal studies

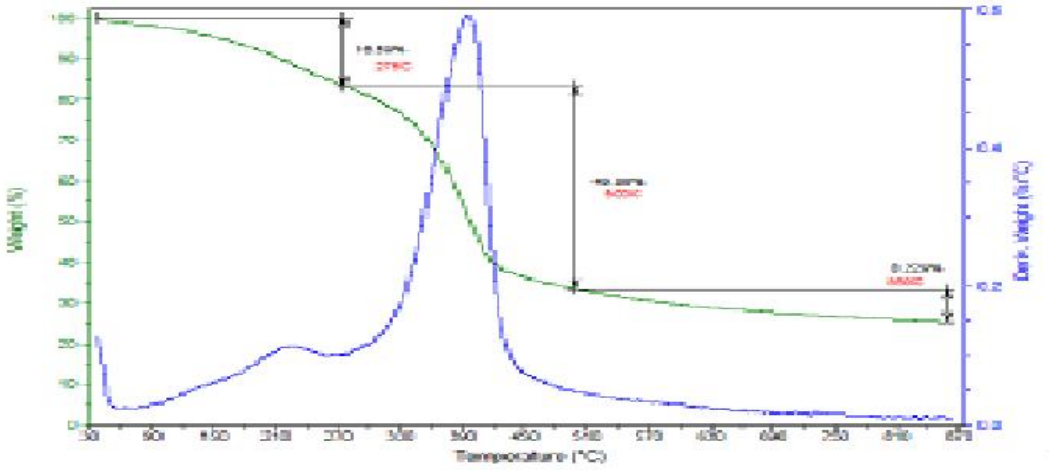


Figure .3 TGA of pure polyester

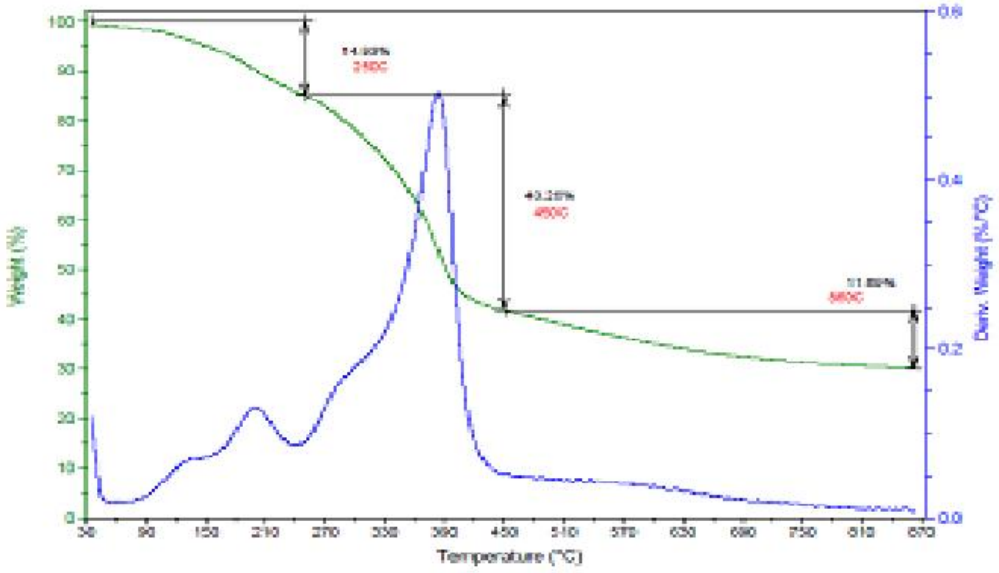


Figure.4 TGA of Polyester-ZnO nanoparticles

All TGA analyses were conducted using a TA Instruments TGA Q500 V20.10 Build 36 thermal analyser, using constant heating rate (200C/min). Thermogravimetric analysis was employed to get information on thermal stability of the prepared composites. It can be observed that all samples have undergone a two stage decomposition with the major weight loss occurring between 300 to 5880 C. Figure 3 & 4 summarised the thermal studies of polyester and ZnO polyster nano composites respectively. The 10% weight loss neat polyester, polyester -ZnO nanparticles, were observed at 2760C and 2300C, respectively. The 20% weight loss found to have around 3000C for both the composites. Thermal stability and retaining capacity was observed for ZnO based nano composites and pure polyester. This might be due to the presence of nanoparticles played a vital role in enhanced.

IV. Conclusions

1. Nano composite have been fabricated and characterised using FTIR, SEM and Thermal analysis.
2. Formations of composites were confirmed by the specific stretching frequencies in FTIR spectral analysis.
3. SEM clearly pointed out the incorporation of nano particles into the polyester matrix.
4. Thermal stability was improved for the nano particles treated polyester than plain polyester. Further, SEM studies well supported the results of thermal studies.
5. Mechanical studies reveal that pure polyester has excellent properties than nanoparticles treated polyester.

V. REFERENCES

[1] A. Usuki, M. Kawasumi, Y. Kojina, A. Okada, T. Kurauchi, O. Kamigaito, Swelling behavior of montmorillonite cation exchanged for v-aminoacid by e-caprolactam, J. Mater. Res. 8 (1993) 1174–1178.

[2] A. Usuki, Y. Kojima, M. Kawasumi, A. Okada, Y. Fukushima, T. Kurauchi, O. Kamigaito, Synthesis of nylon 6 – clay hybrid, J. Mater. Res. 8 (1993) 1179–1184.

[3] P.D. Kaviratna, T. Lan, T.J. Pinnavaia, Synthesis of polyether – clay nanocomposites: kinetics of epoxy-self polymerization in acidic smectite clay, Polymer Preprints 35 (1994) 788–789.

[4] T.J. Pinnavaia, Intercalated clay catalysts, Science 220 (1983) 365–367.

[5] T. Lan, T.J. Pinnavaia, Clay-reinforced epoxy nanocomposites, Chem. Mater. 6 (1994) 2216–2219.

[6] X. Kornmann, H. Lindberg, L.A. Berglund, Synthesis of epoxy–clay nanocomposites: influence of the nature of the clay on structure, Polymer 42 (2001) 1303–1310.

[7] M. Krook, A.C. Albertson, U.W. Gedde, M.S. Hedenqvist, Barrier and mechanical properties of montmorillonite/polyesteramide nanocomposites, Polym. Eng. Sci. 42 (2002) 1238–1246.