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Investigation on Zirconium Oxide Based Unsaturated Polyester Nanocomposites

R.Nathiya[1], G.Elango[1] and S. Guhanathan*[2]
PG and Research Department of Chemistry, Government Arts College, Tiruvannamalai.
PG and Research Department of Chemistry, Muthurangam Government Arts College,
* Email: sai_gugan@yahoo.com

ABSTRACT**: Polymeric material may be inorganic, organic, natural or synthetic. Polymer nano composite are materials of nanoscopic inorganic particles typically 10-100 A^0 in at least one dimension are dispersed in an organic polymer matrix. This type of materials has many important properties such as linear, optical, electronic and conducting. Polymer nano composite exhibits mechanical characteristics, heat resistance and chemical resistance. General purpose unsaturated polyester resin (GPR) combined with organic (cinnamic acid), inorganic (calcium carbonate) and nano zirconium oxide particles based nanocomposites has been synthesized. The casting technique was used to fabricate the composite. FTIR spectral technique have been used to identify the incorporated functional groups of the composites material. The results of spectral studies revealed that successful incorporation of fillers into the GPR matrix.**

KEYWORDS - thermo gravimetric analysis, differential thermal analysis, nanocomposites, FTIR, casting technique, SEM.

I. INTRODUCTION

Unsaturated polyester resins consist of two polymers, i.e., a short chain polyester containing polymerizable double bonds and a vinyl monomer. Polymeric materials have been used increasingly in building construction, in the automotive industry and in aerospace technology. Polymeric materials are virtually able to compete with conventional materials in most industrial fields Desired properties of composites could be achieved by incorporating special fillers into a polymer matrix to suit various applications [1-2]. According to the composition of an unsaturated polyester resin, the monomers can be grouped in two main classes, i.e., components for the polyester and components for the vinyl monomer.

II. COMPOSITES

A composite is a combination of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other materials called the matrix phase [3]. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Examples of some current application of composites include the diesel piston, brake-shoes and pads, tires and the Beech craft aircraft in which 100% of the structural components are composites.

When nanoparticles are embedded in polymer, the resulted composite material is known as polymer nano composite. Nowadays, polymer composites are widely used in many situations where machine components are subjected to tribological loading conditions [4].

III. FILLERS

Any powdery materials can be used as fillers for examples calcium carbonate, clay, alumina, silica, sand, talc, barium sulfate, glass beads, mica, aluminum hydroxide, cellulose yarn, silica sand, river sand, white marble, marble scrap, and crushed stone Fillers reduce the cost and change certain mechanical properties of the cured materials.

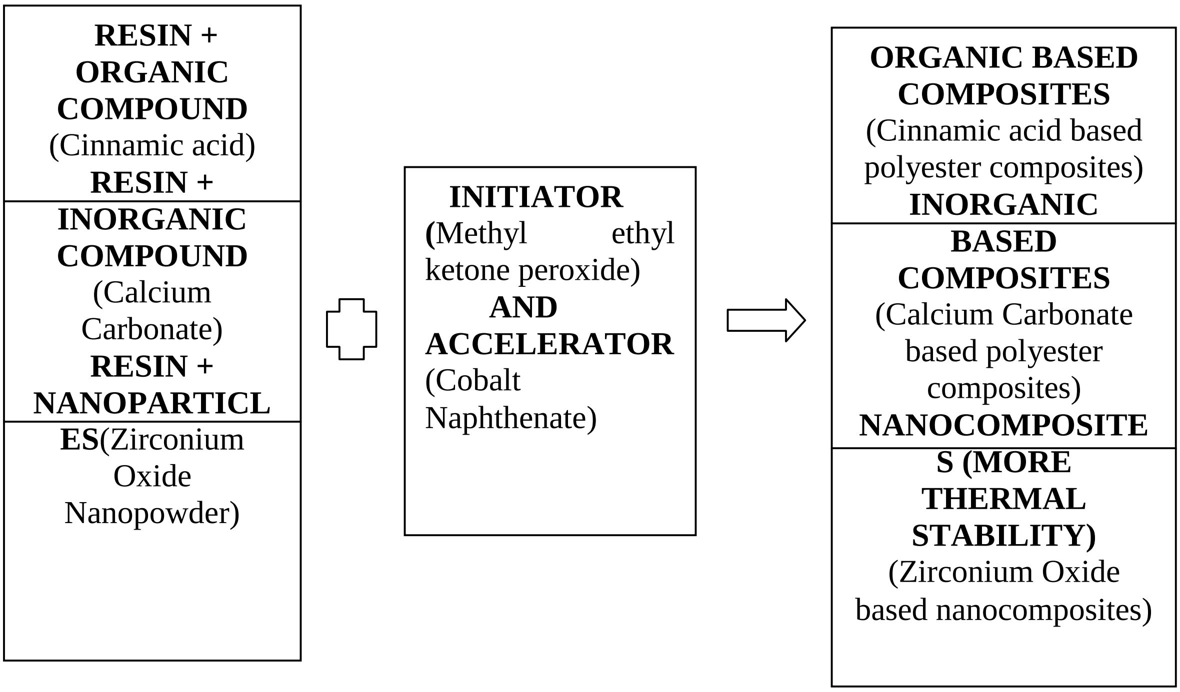
IV. ZIRCONIUM OXIDE (ZrO_2)

Unlike other ceramic materials, zirconium oxide (ZrO_2 –also known as zirconia) is a material with very high resistance to crack propagation. Another outstanding property combination is the very low thermal conductivity and high strength. Research on nanoparticle synthesis [5] has been developed remarkably in recent years, and nanoparticles of various materials in various sizes have become available (Okuyama et al., 2002). Metal nanoparticles have been of great interest recently because of their potential applications in a wide area, especially when dispersed in a polymer resin. The challenging problem is how to disperse nanoparticles in polymer matrix to improve the function of nanoparticles because it is usually difficult to disperse nanoparticles in a polymer matrix without agglomeration. A well-known approach, i.e., mechanical mixing of nanoparticles and a polymer, results in aggregated structures. Therefore, seeking some effective methods for embedding nanoparticles in a polymer matrix, in which, nanoparticles somehow present as isolated entities is greatly important. This hybrid material would be greatly important for use in developing quantum devices.

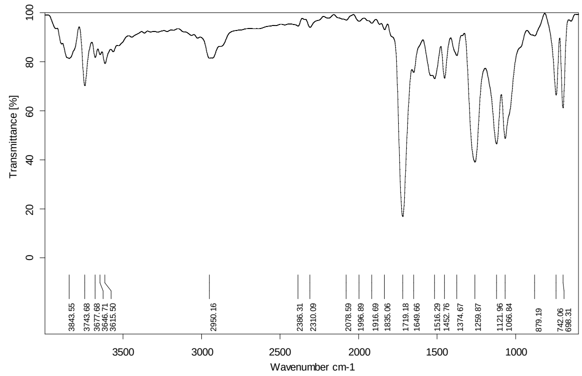
V. MATERIALS

Materials used for preparing various composites are General purpose unsaturated polyester resin, Cobalt Naphthenate, Methyl ethyl ketone peroxide, Zirconium oxide nano powder, Acetone, Cinnamic acid, Calcium carbonate

VI. EXPERIMENTAL METHOD



VII. RESULTS AND DISCUSSION



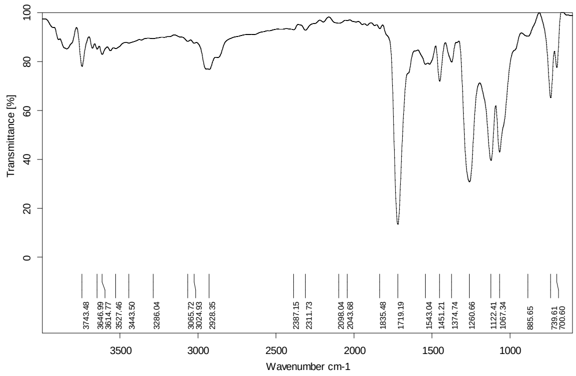
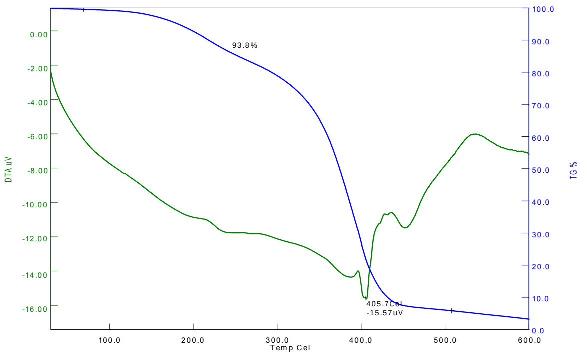
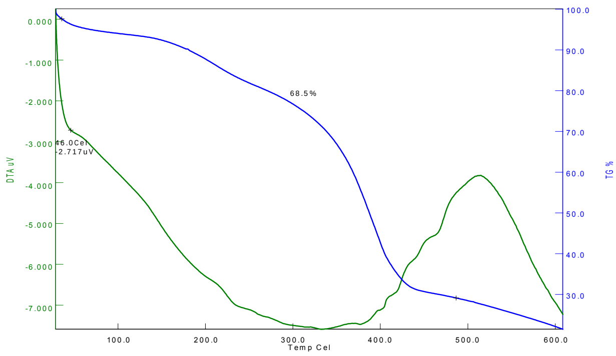


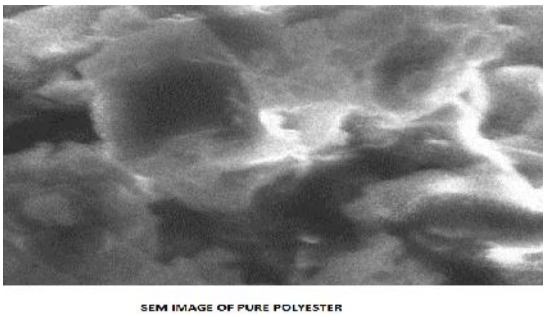
FIG. 1 FTIR spectrum of pure polyester resin. **FIG.2 FTIR spectrum of Zirconium Oxide based Nano Composites**





.4 TG

oxide based nanocomposites



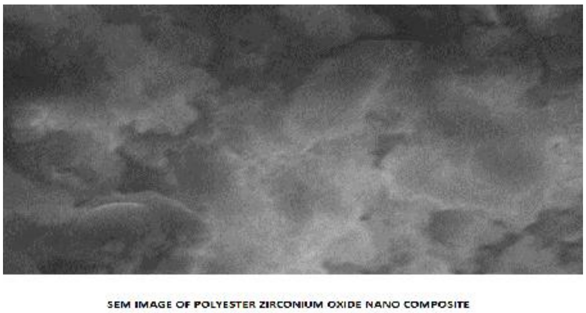


FIG.5 SEM image of pure polyester resin **FIG.6 SEM image of zirconium oxide based nano composites**

All FTIR spectra were conducted, using an Alpha Bruker instrument to determine functional groups in a compound. A scanning electron microscope (JEOL JSM 6460 LA, Perkin Elmer) was used to identify the morphological structure of various composites. All TGA analyses were conducted using a TGA Instrument Modulated TGA 2950 thermal analyser, using conventional (constant heating rate), and modulated modes operating from room temperature to700^{0}C.

The FTIR of pure polyester resin is shown in Figure-1 & 2

- The absorption at 3677.68 cm^{-1} was observed due to presence of –OH stretching.

- The strong absorption at 1719.18 cm^{-1} was observed due to the presence of C = 0 stretching in α, β unsaturated alkyl esters.
- The weak absorption at 1516.29 cm^{-1} was assigned to be aromatic compound.
- The absorption at 1259.87 cm^{-1} showed –C-CO-C- stretching in acetate group.
- The absorption at 1121.96 cm^{-1} and 1066.84 cm^{-1} were shown by strong C = 0 stretching.

The absorption at 742.06 cm^{-1} and 698.31 cm^{-1} were shown by the presence of Mono substituted Phenyl group.

From Figure 3 & 4, 10% of weight loss of pure polyester resin is observed at 220^{o}C and 80% at 410^{o}C.But in zirconium oxide based nanocomposites found 80% of weight loss is observed at 600^{o}C. Thus, zirconium oxide nanoparticles based polyester nanocomposites found to have excellent thermal stability than that of calcium carbonate and cinnamic acid based polyester composites. Figure 5 showed the SEM image of pure polyester resin which clearly pointed out the smoothness in the entire matrix. However, Nano Ziroconium dispersion was identified in the Figure.6. All data mentioned above are well supported the formation of the compound.

VIII. CONCLUSIONS

Polyester - zirconium oxide nanocomposites have been synthesized using relatively simple casting technique and some physical, chemical properties of the composites were investigated and compared with respects to inorganic (calcium carbonate) and organic (cinnamic acid) based polyester composites. Zirconium oxide nanoparticles based polyester nanocomposites found to have excellent thermal stability than that of calcium carbonate and cinnamic acid based polyester composites. Thus, the fabricated zirconium oxide based nanocomposites may safely be recommended for thermal industrial applications.

In future scope of the studies may be extended for mechanical and morphological characterization to find the excellency of material for specific application.

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