International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN: 0974-4290
Vol.9, No.01 pp 308-312, 2016

# Thermal analysis of Fiber Reinforced Low Density Poly-Ethylene Composites

**Subramanian Ravichandran**

**Department of Physics, Sathyabama University, Chennai-600 119. India**.

**Abstract:** Fiber-reinforced polymer is a composite material made of a polymer matrix reinforced with fibers. The fibers are usually glass, carbon, basalt or http://en.wikipedia.org/wiki/Aramid kevlar although other fibers such as paper or wood or asbestos have been used. Polymeric materials reinforced with synthetic fibres such as glass, carbon, and aramid provide advantages of high stiffness and strength to weight ratio as compared to conventional construction materials. The main objective of this work is to get a better understanding of Thermal properties of Low Density Polyethylene (LDPE) Resin composites reinforced with different fibers such as Glass, Carbon and Kevlar. Epoxy resin act as a bond for fiber laminates and the LDPE act as a filler material. The properties of LDPE composites were analyzed by TGA and DA.

## Introduction

Fiber-reinforced polymer (FRP) composites are made by combining a plastic polymer resin together with strong reinforcing fibers. The components retain their original form and contribute their own unique properties that result in a new composite material with enhanced overall performance. Reinforcing polymer material with fibers improves their strength and stiffness. High-strength, lightweight FRP composites have been widely used in defense and aerospace systems for many years and have been used more recently in luxury automobiles, wind turbines, and compressed gas storage tanks. Lightweight, strong and stiff materials make an attractive combination of properties for manufactured products. There is an increase demand for environmental friendly materials such as natural fiber composites to replace the traditional fiber (i.e. carbon, glass, and aramid fiber) composites (1). Arfin Jahan et al (2) studied the Optical, Electrical and Thermal Properties of Jute and Glass Fiber Reinforced LDPE Composites. They concluded that the onset temperature, 50% degradation temperature and maximum slope are at 373.0° C and 487.6° C respectively and The total degradation loss has been observed to be 50.2% .

A better understanding of their thermal behaviors will enable engineers to produce an optimum design for a structure [3-5]. The prepared material is subjected to thermal analysis with the help of thermal gravimetric analyzer and differential scanning calorimeter. Thermal properties of composites are measured using thermo gravimetric analysis (TGA) and differential thermal analysis (DTA).

The high potential of the applicability of polymeric composites in new industrial construction correlated with fabrication procedures as well as the use of composites in modern strengthening solutions are presented in the project. The thermal degradation properties of the fiber reinforced Low density Poly-Ethylene (LDPE)-Resin composites were studied using Thermo-Gravimetric Analyzer.

## Experimental

The mixture of Low density polyethylene (LDPE) and the solvent is taken in the suitable ratio. The dissolved LDPE solute is then allowed to cool down at room temperature. Then the solidified smooth LDPE is powdered. The powdered LDPE is then mixed with the epoxy resin. Then the weight of the fiber is measured. LDPE powder and epoxy resin is mixed equivalent to weight of the fiber. This mixture is stirred well using a magnetic stirrer. After this process, hardener is added to the LDPE and epoxy mixture. To simplify the mixing process, the LDPE-resin mixture is preheated to about 30 °C to 50 °C before adding the hardener.

The spacer of 5mm thickness and 300mmx300mm (inner dimension) is mounted on the compression molding machine. Then layers of glass fibers (300mmx300mm) are placed one another by applying the LDPE and resin mixture using hand layup roller. Both the sides of the spacer are covered by polythene sheet coated with wax. Wax coated polythene sheets prevent the composite films binding to the compressing molding machine. A temperature of about $80^0$ C and pressure of 0.2 (3 psi) bar is maintained for 2 hours for the FRP composite to get cured. The same procedure is adopted for the fabrication of LDPE carbon and LDPE Kevlar fiber composites. The thickness of a composite film was maintained as per the ASTM standard.

## Result and Discussion

TGA was used to characterize the decomposition and thermal stability of materials under a variety of conditions, and to examine the kinetics of the physico-chemical processes occurring in the sample. Basically in this method a change in thermal stability was examined in terms of percentage weight loss as a function of temperature. The mass change characteristics of a material were strongly dependent on the experimental conditions such as sample mass, volume, physical form; shape and nature of the sample holder, nature and pressure of the atmosphere in the sample chamber and the scanning rate, all have important influences on the characteristics of the recorded TG curve. At the same time, DTA involves comparing the precise temperature difference between a sample and an inert reference material, while heating both. DTG is a type of thermal analysis in which rate of material weight changes upon heating vs temperature is plotted and is used to simplify reading of weight versus temperature thermogram peaks that occur close together [6].

Thermal analysis of composite materials, such as carbon fibre composites or glass epoxy composites are often carried out using DMA or DMTA, which can measure the stiffness of materials by determining the modulus and damping (energy absorbing) properties of the material. DTA curve provides data on the transformations that have occurred: glass transitions, crystallization, melting and sublimation. Area under a DTA peak is the enthalpy change and is not affected by the heat capacity of the sample.

Figure 1-4 Shows that the Thermo gravimetric (TG) and Differential (DTA) Thermo gravimetric analysis for LDPE fiber composites. According to the TG analysis it is observed that the major degradation occurs at two steps for the LDPE fiber composites: one is related to fiber degradation while another one is due to polymer degradation. The difference between the starting and final weight of the sample represents the weight of the polymer burned off during the experiment. TGA experiments were run to a maximum temperature of $1000^oC$. TGA is commonly used to determine selected characteristics of materials that exhibit either mass loss or gain due to decomposition, oxidation, or loss of volatiles.

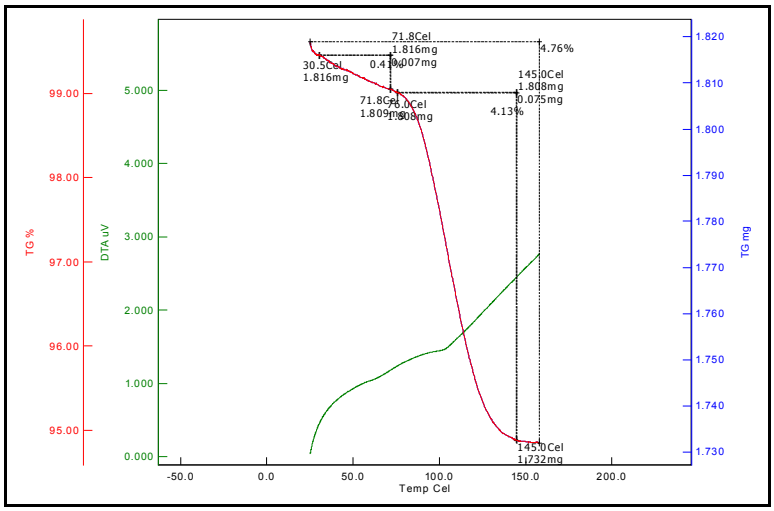


**Figure 1. TGA analysis for LDPE resin composite**

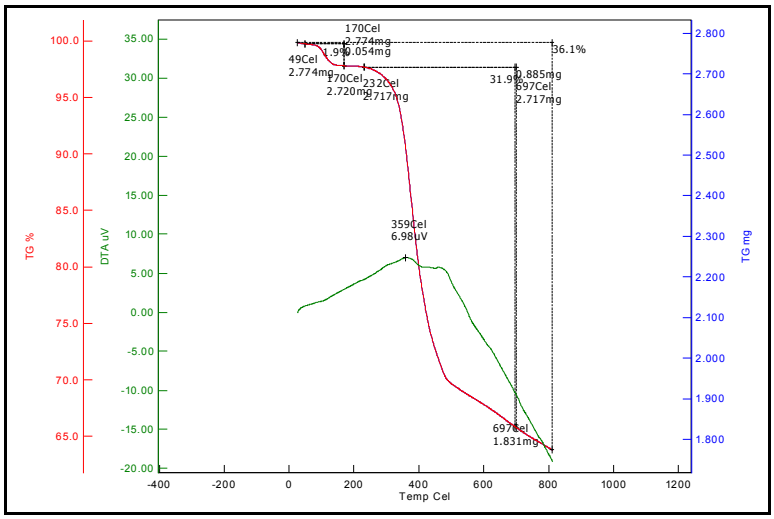


**Figure 2. TGA analysis for LDPE -Glass Fiber Composite**

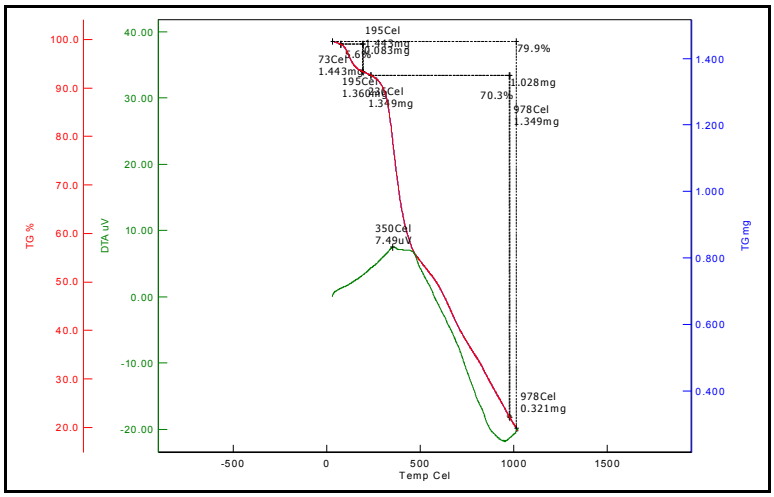


**Figure 3. TGA analysis for LDPE- Carbon Fiber Composite**

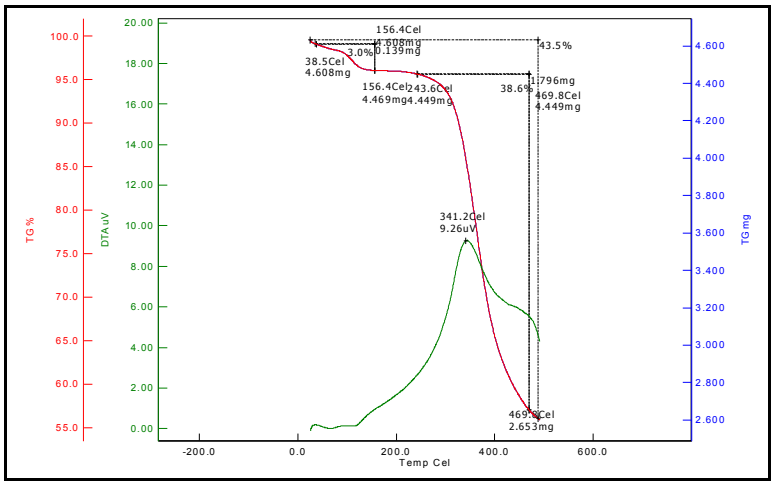


**Figure 4. TGA analysis for LDPE- Kevlar Fiber Composite**

The TGA thermo gram and DTA curve of LDPE-Epoxy resin- composite with glass, carbon and kevlor fiber are shows in Figure 1- Figure 4. It is observed that the initial decomposition of a material at 200'C-300'C. At the initial temperature, the loss in weight is very less, in the composite material. This small variation observed in TG thermo gram may be due to the nature of fibers [6-7]. The second stage of weight loss starting at 400-750'C represents the degradation of the composites and molecular weight of polymers. From 800-975'C, a small variation takes place in the decomposition of a materials in which almost 60% of mass loss is observed in the glass fiber composites. 38% of residue obtained at a temperature of 800'C. But, the polymer nano composite material containing carbon fiber, 80% residue is obtained at 1000'C and a composite material with Kevlar has a residue of 43% at 470'C. In the LDPE-resin composites, TG study shows that loss at 71.8 $^{o}$ and total degradation at 145 $^{o}$. 36.1% loss occurred at 170 $^{o}$ in the LDPE-glass fiber composites. Two endothermic peaks at 359 $^{o}$ and another one is at nearly 430 $^{o}$. This is due to the fiber and polymer degradation. Maximum temperature of composites are 800 $^{o}$ for the composites with glass fiber,978 $^{o}$ for the composites with carbon fiber(0.321mg). A peak occurs at 350 $^{o}$ (7.49uV). While, the maximum peak at 341.2 $^{o}$ (9.26uV). Here, 43.5% loss at 156.4% and maximum loss at 469.8 $^{o}$ (2.653mg) [8-10].

## Conclusion

The onset and end set of thermal degradation temperature were determined from TG analysis. The results indicated that, the reinforcement of Glass, Carbon & Kevlar fiber should affect the weight loss of composites.

## References

1. Josmin P. Jose, Sant Kumar Malhotra, Sabu Thomas, Kuruvilla Joseph, Koichi Goda, and Meyyarappallil Sadasivan Sreekala. Introduction to Polymer Composites: Wiley-VCH publication, I st Edn., 2012,1, 1-16.
2. Arfin Jahan, Mahbubur Rahman M, Humayun Kabir, Md Alamgir Kabir, Farid Ahmed, Md. Abul Hossain, Md Abdul Gafur. Optical, Electrical and Thermal Properties of Jute and Glass Fiber Reinforced LDPE Composites. Int J Basic & App Sc., 2013, 1; 482-490490.
3. Kim S, Lee S, Kang J and Kang K. Thermal Conductivity of Thermoplastics Reinforced with Natural Fibers. Intl J Thermophy., 2006, 27; 1873-1881.
4. Carola Esposito Corcione and Mariaenrica Frigione. Characterization of Nanocomposites by Thermal Analysis., Mater., 2012, 5; 2960-2980.
5. Barraza HJ, Pompeo F, O'Rear EA, and Resasco DE. SWNT-filled thermoplastic and elastomeric composites prepared by miniemulsion polymerization. Nano Lett., 2002, 2 , 797- 802.
6. Singha AS, and Vijay Kumar Thakur. Mechanical properties of natural fibre reinforced polymer composites. Bull Mater Sci., 2008, 31; 791-799.
7. Singha AS, and Vijay Kumar Thakur. Synthesis and Characterization of S.Cilliare Fiber Reinforced Green Composites. Int J Plast Tech.,2007, 11; 835-851.

8. Singha AS, and Vijay Kumar Thakur, Saccaharum Cilliare Fiber Reinforced Polymer Composite. E-J Chem.,2008, 5; 782-791.
9. Rajkumar K, Nivashri Kumari, Ranjith P, Chakraborty SK, Thavamani P, Pazhanisamy P and Jeyanthi P. High temperature resistance properties of NBR based polymer nanocomposites. Int J Chem Tech Res.,2011, 3; 1343-48.
10. Suriani Ibrahim, and Mohd Rafie Johan. Thermolysis and Conductivity Studies of Poly(Ethylene Oxide) (PEO) Based Polymer Electrolytes Doped with Carbon Nanotube.J. Electrochem. Sci., 2012, 7; 2596-2615

*****