Studies on Mechanical and Thermal Bheviours of Nano Clay Filled Linear Low Density Polyethylene Composites

S.Krishnamoorthi, S.Nagendharan G.Manikandan, R.Karthikeyan

Abstract: ***Nowadays, most of engineering applications the polymer composites are utilize. In this paper we are investigated the only polymer matrix composites. The polymer matrix composite materials are has good strength and better lightweight materials. Composites were fabricated by a compression molding method using the Nano clay with varying weight percentages. Studies on mechanical properties of tensile strength, flexural strength and impact strength are investigated. The thermal behaviors have been investigated by using simultaneously thermal analysis equipment. The maximum tensile strength of 29.6 Mpa at 4 wt. % of Nano clay and 96 Wt. % of LLDPE compositions have been achieved. The maximum flexural strength has been observed as 8.9 Mpa and the impact strength as 236.4 KJ/M.SQ. Thermogravimetry analysis showed that mass loss decreases very slightly in the LLDPE/Nano clay Nano composite compared with those in neat LLDPE, and increased with the increase of Nano clay concentration. The analysis of thermal degradation in airflow showed a clear improvement of thermal stability for LLDPE/Nano clay Nano composites, proportionally to Nano clay content.***

Keywords: LLDPE, polymer matrix composites, compression molding, tensile strength, flexural strength and impact strength, Thermogravimetry, Nano composites, Nano clay.

I. INTRODUCTION

Originating from early agricultural societies and being almost forgotten after centuries, a true revival started of using lightweight composite structures for many technical solutions during the second half of the 20th century. If we are changing the composites materials structure automatically the electromagnetic properties will be increased now a day's manufacturing cost and operation cost is the major area in the researching. Latest development is the use of composites to protect man against fire and impact and a tendency to a more environmental friendly design, leading to the reintroduction of natural fibers in the composite technology, see Increasingly now a days, the success of composites in applications, by volume and by numbers, can be ranked by accessibility and reproducibility of the applied manufacturing techniques. In future, composites will be manufactured even more according to an integrated design process resulting in the optimum construction according to parameters such as shape, mass, strength, stiffness, durability, costs, etc. The new design tools definitely able to change these parameters. The composites materials produced from the two or more materials combined to make one materials. The physical properties and chemical properties of composite materials difference. Polyethylene is the most common plastic.

The copolymerization process produces an LLDPE polymer that has a narrower molecular weight distribution than conventional LDPE and in combination with the linear structure, significantly different rheological properties. LLDPE has higher tensile strength and higher impact. The composites materials we can produce desire shape and properties. It has good resistance to chemicals. It has good electrical properties. LLDPE materials are not easy to handle. It is very good mechanical properties and excellent thermal properties. Nano clay is also known as Nano clay minerals. Are composed of thin layers, each layer has a thickness of one to a few nanometers, and a length from a few hundred to several thousand nanometers.

Nano clay first type is found in the world is montmorillonite (in Montmorillon. Montmorillonite (abbreviated as MMT) of heading smectite , along with other minerals such as kaolin , palygorskit , sepiolit , ... are kind of important industrial mineral. Smectite minerals commonly known by the name bentonite , this is the name of a type of rock consisting mainly of this mineral. Disagreement occurs between experimental and theoretical data as filler volume fraction of the composites increases. [1]. The SiC particles distributions were found to be rather uniform in matrix at both low and high filler content due to a powder mixing process employed.[3]. However, a decrease in the energy required for the fusion of the crystalline parts was noted when the content of the filler in the composite increased. [8]. It could uniformly disperse into a linear low-density polyethylene matrix and provide LLDPE/MWNTs Nano composites much improved mechanical properties [10]. The TGA results show that the MAPP/LLDPE blend and composites are more thermally stable than the PP/LLDPE blend and composites. [11]. It can be concluded that the crystalline features of HDPE have not been influenced greatly by addition of both silver and copper modified silica nanoparticles. Probably, the presence of nanoparticles prevents the growth of HDPE crystals due to small antiparticle distances. [15].

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II. RESEARCH GAP

Many researchers have attempted to find the mechanical properties of cenosphere filled in polyethylene composites, E-glass fiber, phenolic, polypropylene, high density polyethylene (HDPE), rubber, and vinyl ester. But no one used research in Nano clay filled LLDPE composites of the mechanical properties and thermal properties.

III. MATERIALS AND METHODS

A. MATRIX MATERIALS

Powdered linear low density polyethylene (LLDPE) with peak melting temperature of 128°C, was obtained from Kenwood industries at Goa, India. The Density of LLDPE materials is 0.915 g/cm^3 and Melting point is 120 to 160 ºc. The tensile strength of LLDPE is 17.75 MPa. Then impact strength of the LLDPE is 65 KJ/M.SQ. Polyethylene is the most common plastic. Its primary use is in the packaging (plastic bags, plastic films, geomembranes, including containers bottles, etc.).

B. FILLER MATERIALS (NANO CLAY POWDER)

Powdered Nano clay with peak melting temperature of 1780°C was obtained from. The Nano clay particle size is 180 nm, Density is 2.35 (g / cm3), Melting point 1,780 °C, Tensile Strength are10 MPa. Crystal system monoclinic, The color white, yellow Characteristic crystals swell many times when water absorption Some documents published by Nano clay chemical composition of: Al = 9.98%, Si = 20.78%, H = 4.10% and 65.12% O. Nan clay is inorganic, hydrophilic. While background polymer material to fabricate Nano composite is the organic matter and usually hydrophobic. Some other lightning denaturant can be used directly during the fabrication of polymer materials Nano composite because these substances can either participate directly in polymerization or polymerization catalyst.

Figure 1.1 photographic images of Nano clay powder (180nm)

C. COMPOSITE FABRICATION

A compression molding machine was used for composite fabrication. A stainless steel mold having size of 300 mm×300 mm×3 mm was used for composite fabrication in compression molding process. The operating pressure of 3 MPa and temperature of 130°C was maintained for 30 mints for uniform curing of composite sheets. The low temperature curing polyethylene. Nano clay powders with average size 180 NM are reinforced in LLDPE resin to prepare the composites. The dough (Nano clay filled with LLDPE composites) is then slowly poured into the molds, the mold is held between the heated platens at a temp around 130°C of the hydraulic press.

The compound softens and flows to shape; the chemical cure then then occurs as the internal mold temperature becomes high enough. The thermosets polymer we can't reproduce and can't melt in these materials. The press is opened and the molding removed. The different compositions (such as 1, 2, 3, 4, 6, 8, 10 wt. %). The molding curing time is 30 mints and after cure that fabrication materials to check the properties.

Table.1.1 Compositions of Prepared Composites

COMPOSITION DESIGNATION	LLDPE (wt %)	NANO CLAY (wt %)
Nano clay 1	99	1
Nano clay 2	98	2
Nano clay 3	97	3
Nano clay 4	96	4
Nano clay 6	95	5
Nano clay 8	92	8
Nano clay 10	90	10

IV. RESULTS AND DISCUSSION

The tensile test is only the flat type specimen used to take the readings. During the test a load is applied on the flat type materials. The ASTM standard test method for tensile properties of particles resin composites has the designation D 638. The specimen dimension of 165 mm × 25 mm × 3mm. The tensile specimen had straight-sided, constant cross-section. The tensile specimen was held in a testing machine by wedge action grips and pulled at a crosshead speed of 5 mm/min. The fig. 1.2 shows the tensile properties of the pure LLDPE and Nano clay reinforced with LLDPE composites. It can be seen that tensile strength enhanced obviously with the addition of Nano clay in the composite. The tensile strength of pure LLDPE having 29.6 Mpa at 4 wt. % of Nano clay reinforced composite is increased the tensile strength. We obtained the better tensile strength of the composite are 4 wt. % of Nano clay reinforced composite. This composite have good strength of the composites.

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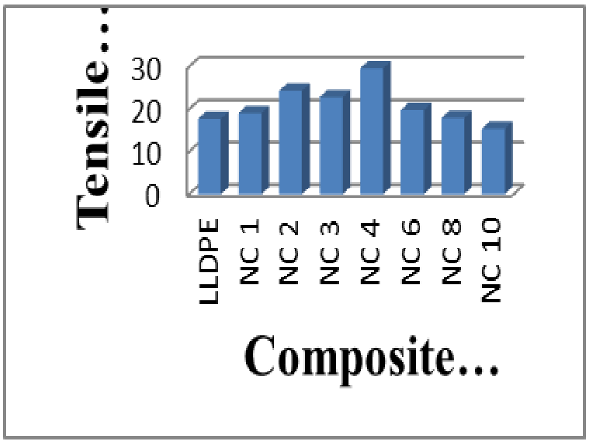

Figure 1.2 Tensile Properties of LLDPE/Nano Clay Composite at Different Weight Percentage

A.FLEXURAL TEST

The flexural test is taken by ASTM D3039-76 test standards. The vertical loads applied on the composite materials. The size of flexural test specimens is 125 mm specimens parallel to the loading direction. The specimen dimension 125 mm × 12.5 mm × 3 mm. after applied the loads that specimens bended the center point, so the results was obtained. The flexural strength of the pure LLDPE and Nano clay reinforced with cenosphere composites. It is observed that the flexural strength increased obviously with that addition from 4 wt. %. The unreinforced LLDPE shows the flexural strength of 12 MPA. Figure 3 shows the flexural properties of LDPE/Nano clay with varying amounts of Nano clay loading. From Figure(1.3), a rise was observed in flexural strength by about 4%, upon addition of 6wt% Nano clay into the blend. At 4wt% Nano clay loading, the flexural strength of the blend was quite closer to that of native LDPE. The influence of Nano clay content on flexural modulus of LDPE/Nano clay blends are shown in Figure (1.3). Addition of Nano clay resulted in a progressive increase on flexural modulus. The result illustrated the fact that the properties of binary LDPE/Nano clay blend depend on the properties of the blend constituents.

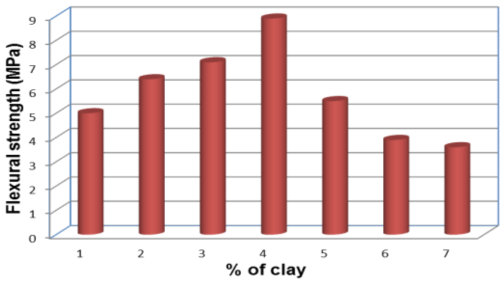

Figure 1.3 Flexural Properties of LLDPE/Nano Clay Composite at Different Weight Percentage

B. IMPACT TEST

Impact strength testing was carried out using a Tinius Olsen Impact tester as per ASTM D256. The sample was incised into the dimension of 67.5 mm× 12.5 mm× 3 mm. The test specimens are supported in the both ended. Five readings for each identical specimen were taken and their average result was taken. The tests were carried out at room conditions for the temperature and the relative humidity of 55%. In this test the structure of the materials is very important. The sixth specimen of composites has uniformly increasing, when apply the loads.

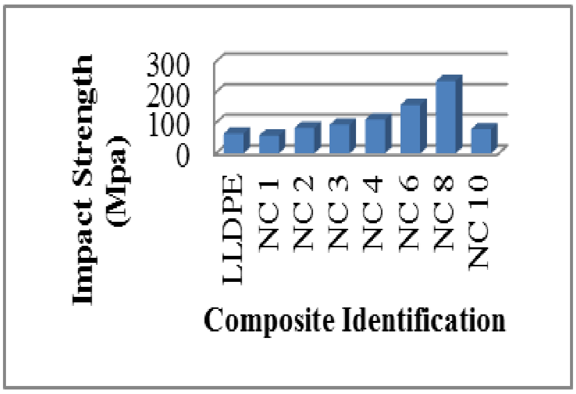

Figure 1.4 Impact Properties of LLDPE/Nano Clay Composite at Different Weight Percentage

The thermal gravimetric analysis (TGA) method is a thermal analysis of composites materials. TGA can provide information about physical phenomena, such as second order phase transitions, including vaporization, sublimation, and absorption and desorption. TGA method used to determine the chemical composition, oxidation and reaction of compositions. 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 (such as moisture). Common applications of TGA are (1) materials characterization through analysis of characteristic decomposition patterns, (2) studies of degradation mechanisms and reaction kinetics, (3) determination of organic content in a sample, and (4) determination of inorganic.

Thermal stability, oxidation, and combustion, all of which are possible interpretations of TGA traces, will also be discussed. Thermogravimetric analysis (TGA) is a high degree of precision measurements. Therefore, the basic instrumental requirements for TGA are a precision balance with a pan loaded with the sample, and a programmable furnace.

TGA being the most basic and the simplest of all the thermo-analytical method. The measurement of the sample may be carried out in presence of inert atmosphere (nitrogen), at constant heating rate, and the change in weight is recorded as a function of increasing temperature. Maximum temperature is selected such that the sample weight is stable at the end. This approach gives important information about the sample, i.e.; the ash content (residual mass), the temperature of maximum degradation and the melting temperature. This technique is effective for quantitative analyses of thermal reactions that are accompanied by mass changes viz. evaporation, decomposition, dehydration, gas absorption and desorption and helps in deciding the end use application of the composites. In this study polymer matrix, composite samples were heated from room temperature to 20ºC/min in presence of nitrogen atmosphere.

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C. THERMAL PROPERTIES OF COMPOSITES

The thermal gravimetric analysis (TGA) method is a high thermal analysis test. It is the properties of materials are studied as they change with temp. Generally TGA is the 20ºc/min and starting temperature from 0 to 1000 ºc. The nitrogen gas used to prevent the oxidation or undesired reaction.

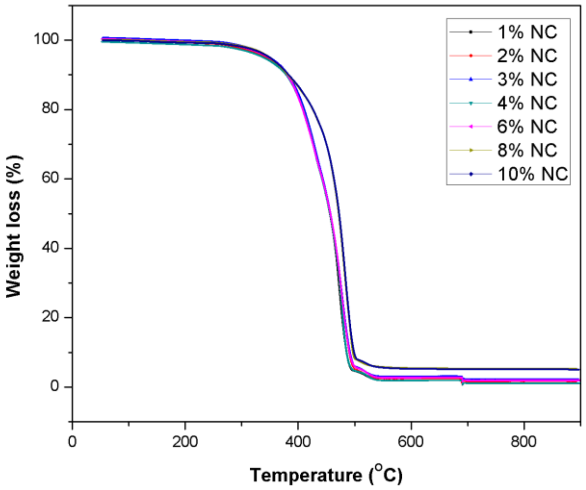

Figure 1.5 TGA Curves Of LLDPE/Nano Clay Nano Composites

The LLDPE/Nano clay composites specimens are used to find the thermal properties of materials. Switch ON the TGA equipment and coolant are used to reduce the heat of the TGA equipment. The nitrogen gas also opens to pass through the inside of the TGA equipment. The LLDPE/Nano clay powder put on the disc and close to equipment cap. The LLDPE/ Nano clay powder composition is 1, 2, 3, 4, 6, 8, 10 wt. %. TGA evaluates mass loss of a material as a function of temperature. A continuous graph of mass change against temperature is obtained when a sample is heated at a constant rate. A plot of percept mass change *v/s* temperature is referred to as thermo gravimetric (TG) curve. Figure 1.5 shows the dependence of the decomposition temperature on Nano clay content. It can be seen that the overall thermal stability of LLDPE/Nano clay Nano composites, compared with neat LLDPE, is clearly improved. The thermal stability of LLDPE/Nano clay Nano composites may be closely related to following factors: the dispersion state and the loading content of Nano clay. The decomposition temperature of LLDPE/Nano clay Nano composites increases slightly with increasing Nano clay loading content, probably due to the ease of compact char formation for the Nano composites during the thermal degradation. On the other hand, high concentration Nano clay would definitely prevent its fine dispersion, and more aggregation or bundles could often be formed because of van der Waals force among the Nano clay, thus deteriorating the thermal stability of the Nano composites. It is necessary to research the competing effect between the dispersion state and the loading content of Nano clay in depth.

V. CONCLUSION

1) The experimental investigation on the effect of filler content on mechanical behavior of epoxy composites,
2) The LLDPE/NANOCLAY composites are fabricated the difference compositions.
3) Tensile and impact properties of Nano clay filled LLDPE composites were evaluated as per ASTM D638 and ASTM D256 respectively.
4) The present investigation revealed that 4 wt. % Nano clay filled LLDPE composites are good tensile strength and, impact strength also better in 6 wt. % LLDPE composites.
5) The fabrication of LLDPE content and particulate content had a significant role on the tensile and Impact strength of the Nano clay filled LLDPE composites.
6) The tensile strength was obtained as 29.6 MPa for the Nano clay filled composites and impact strength as 236.4 KJ/M.SQ
7) Thermograviometry analysis showed that mass loss decrease very slightly in the LLDPE/Nano clay Nano composite compared with those in neat LLDPE, and increased with increase of Nano clay concentration. The analysis of thermal degradation in airflow showed a clear improvement of thermal stability for LLDPE/Nano clay Nano composites, proportionally to Nano clay content.

VI. SCOPE OF THE PROJECT

In this area the only few research scholars to investigate. So the further work of this paper to find the crystal structure and wear test.

Mechanical and Erosion Behavior.

- To study the wear and friction behaviour of LLDPE/Nano clay composites.
- To study the thermal behaviour of LLDPE/Nano clay composites.

To study the dimensional stability of LLDPE/Nano clay composites.

REFERENCE

1. R. Nawang, I.D. Danjaji, U.S. Ishiaku, H. Ismail, Z.A. Mohd Ishak 2000, Mechanical properties of sago starch-filled linear low density polyethylene (LLDPE) composites, Polymer Testing 20 (167–172).
2. M.A. Mokoena, V. Djokovi, A. S. Luyt, 2004, Composites of linear low density polyethylene and short sisal fibres, Materials Science 39 (3403 – 3412).
3. Wenying Zhou, Demei Yu, Chao Min, Yinping Fu, Xiusheng Guo, 2008, thermal, dielectric, and mechanical properties of sic particles filled linear low-density polyethylene composites, polymer testing.
4. Wenying Zhoua, 2011, thermal and dielectric properties of the aln particles reinforced linear low-density polyethylene composites,
5. Dr. M. S. R Niranjan Kumar, 2014, Effect of Nano clay on the Tensile properties of Polyester and S-glass Fibre(Al)" M. Somaiah Chowdary, International Journal of Engineering Research & Technology, (IJERT).
6. Girish Chandran V., Sachin D. Waigaonkar, 2015, Mechanical Properties and Creep Behaviour of Rotationally Mouldable Linear Low Density Polyethylene-Fumed Silica Nano composites, polymer composites.
7. I.N. Hidayah, M. Mariatti, H. Ismail and M. Kamaro, 2016, Effect of selective localization on dielectric properties of boron nitride Nano filler filled linear low density polyethylene (LLDPE)/silicone rubber (SR) blends, Polymer Testing.
8. Kamil Şirin, Mehmet Balcan and Fatih Doğan, 2012, the influence of filler component on mechanical properties and thermal analysis of pp-ldpe and pp-ldpe/dap ternary composites

9. Anshu Anjali Singh and Sanjay Palsule, 2014, Thermal Properties of Jute Fiber Reinforced Chemically Functionalized High Density Polyethylene (JF/CFHDPE) Composites Developed by Palsule Process, Applied Polymer Composites, Vol. 2, No. 2, 2014.
10. Tai Jin-huaa, Liu Guo-qinb, Caiyi Huangc, Shangguan Lin-jiana, 2012, Mechanical Properties and Thermal Behaviour of LLDPE/MWNTs Nano composites, Materials Research. 2012; 15(6): 1050-1056.
11. G. Dikobe, A. S. Luyt, 20110, Comparative study of the morphology and properties of PP/LLDPE/wood powder and MAPP/LLDPE/wood powder polymer blend composites, eXPRESS Polymer Letters Vol.4, No.11 (2010) 729–741.
12. P. Noorunnisa Khanam, MA AlMaadeed1, M. Ouederni3, Eileen Harkin-Jones, Beatriz Mayoral, Andrew Hamilton, Dan Sun, 2016, Melt Processing and Properties of Linear Low Density Polyethylene-Graphene Nanoplatelet Composites, Vacuum, 130, 63-71.
13. Shaharuddin Kormin, Faridah Binti Kormin, Mohammad Dalour Hossen Beg, Mohd Bijarimi Mat Piah, 2015, Study the Physical, Mechanical, Thermal And Morphological Properties Of Ldpe/Sago Starch Blend, ARPN Journal of Engineering and Applied Sciences.
14. N. Shebani And A. J. Van Reenen, 2009, The Effect Of Wood Species On The Mechanical And Thermal Properties Of Wood–Lldpe Composites, Journal Of Composite Materials, Vol. 43, No. 11/2009.
15. Regina Jeziórska,1 Maria Zielecka,1 Beata Gutarowska,2 and Zofia gakowska2, 2013, High-Density Polyethylene Composites Filled with Nanosilica Containing Immobilized Nanosilver or Nanocopper: Thermal, Mechanical, and Bactericidal Properties and Morphology and Interphase Characterization, International Journal of Polymer Science Volume 2014.
16. Junwei Gu, Qiuyu Zhang, Jing Dang, Junping Zhang, Zhaoying Yang, 2009, Thermal Conductivity And Mechanical Properties Of Aluminum Nitride Filled Linear Low-Density Polyethylene Composites, Polymer Engineering And Science.
17. Karthick, S., Perumal Sankar, S., and Raja Prathab, T. “An approach for image encryption/decryption based on quaternion Fourier transform”, 2018 International Conference on Emerging Trends and Innovations In Engineering And Technological Research, ICETIETR 2018, art. no. 8529014, 2018. DOI: 10.1109/ICETIETR.2018.8529014
18. Karthick, S. “Semi supervised hierarchy forest clustering and knn based metric learning technique for machine learning system”, Journal of Advanced Research in Dynamical and Control Systems, vol. 9, no. Special Issue 18, pp. 2679-2690, 2017.
19. T. Sathish, “BCCS Approach for the Parametric Optimization in Machining of Nimonic-263 alloy using RSM”, Materials Today Proceedings, Elsevier Publisher, Vol. 05, Issue 6, pp. 14416-14422, 2018.
20. Venkatesh, R., Vijayan, V., Parthiban, A., Sathish, T., Siva Chandran, S. “Comparison of Different Tool path in Pocket Milling”, International Journal of Mechanical Engineering and Technology, Vol. 09, Issue. 12, pp. 922-927, 2018.
21. Sathish, T., and Karthick, S. “HAIWF-based fault detection and classification for industrial machine condition monitoring”, Progress in Industrial Ecology, vol. 12, no. 1-2, pp. 46-58, 2018
22. Madan, D., Sivakandhan, C., Sagadevan, S., Sathish, T. “Ocean Wave Energy Scenario in India”, International Journal of Mechanical and Production Engineering Research and Development, Special Issue, pp. 582-590, 2018.
23. Sathish, T., Vijayakumar, M.D., Krishnan Ayyangar, A. “Design and Fabrication of Industrial Components Using 3D Printing”, Materials Today Proceedings, Elsevier Publisher, Vol. 05, Issue 6, pp. 14489-14498, 2018.

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