Property Evaluation of Polypropylene Hybrid Composite with Nano Clay

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Abstract— Composites are widely used in the area of aeronautical applications where the weight reduction is the common factor.In this Polymer composite is the commonly used one where the Polypropylene is the used matrix. Polypropylene (PP), also known as polypropylene, is a thermo plastic polymer used in wide variety of applications including packaging and labeling, textiles, stationery, plastic parts and reusable containers of various types, laboratory equipments and automotive components. .Composites have the ability to meet diverse design requirement with significant strength to weight ratio as compared to conventional materials and having great strength, higher fatigue endurance limit, lower embedded energy, good impact properties, environmental and corrosion resistance and can be tailored to meet performance needs and complex design requirements. The present study investigates the effect of nanoclay in the Polypropylene composites.In this experiment the aluminium oxide is fixed as 3% with reference to the previous work done by the author.The composition of nanoclay is varied from 2% to 5%.The composite is prepared by mixed blending technique.The specimen is prepared according to the ASTM standard in injection moulding machine.Testing is done on the specimen to evaluate the mechanical properties of the composite. The lower loading facilitates processing and reduces component weight. Fillers are added to enhance the properties, Auminium oxide is used where compressive and frictional forces dominate [2]. The addition of nano clay [1] will increase the stress intensity factor and strain release rate of virgin polypropylene.

Keywords— Polypropylene, Twin screw Extruder, Nano clay, Aluminium oxide.

I. Introduction

Composites are combination of two or more than two materials in which one of the material, is reinforcing phase (polymer, metal or ceramic). Composite materials are usually classified by type of reinforcement such as polymer composite, ceramic and metal matrix composites. Polymer composite materials are mostly commercially produced composites in which resin is used as matrix with different reinforcement material [3]. Polymer (resin) is classified as thermoplastics and thermo set plastics which reinforces different types of natural and manmade fibers for different applications. Common fiber reinforced composites are composed of fibers and a matrix.

Fibers are the reinforcement and the main source of strength while the matrix glues all the fibers in shape and transfers stress between the reinforcing fibers. The primary function of the fibers is to carry the loads along their longitudinal directions. The primary function of the matrix is to transfer stresses between the reinforcing fibers and protect the fibers from mechanical and/or environmental damages. Most matrices are made of resins for their wide variation in properties and relatively low cost.

Polymer nano composites, or more appropriately polymer nano structured materials, represent a radical alternative to the conventional filled polymers and polymer blends, in which discrete constituents on the order of a few nanometers are incorporated in the polymer matrix. In contrast to conventional system, where the reinforcement is of the order of microns, Polymer Nano composites are exemplified by discrete constituents of the order of few nanometers (<100 nm) in at least one dimension. The small size of the fillers leads to an exceptionally large interfacial area in the composites. The interface controls the degree of interaction between the filler and the polymer and thus controls the properties [1-9]. As in conventional composites, the interfacial region is the region beginning at the point in the fiber at which the properties differ from those of the bulk filler and ending at the point in the matrix at which the properties become equal to those of bulk matrix [3]. The properties of nano composites are greatly influenced by the size scale of its component phase and the degree of mixing between the two phases [3].

Polypropylene (PP), also known as polypropylene is made from the monomer propylene; it is rugged and unusually resistant to many chemical solvents, bases and acids. Polypropylene was first polymerized to a crystalline isotactic polymer by Giulio Natta as well as by the German chemist Karl Rehn in March 1954. This pioneering discovery led to large-scale commercial production of isotactic polypropylene by the Italian firm Montecatini from 1957 onwards. Syndiotactic polypropylene was also first synthesized by Natta and his coworkers.

II. EXPERIMENTAL WORK

The polypropylene has so many applications in the recent scientific field and other related areas. To increase the properties of polypropylene it is reinforced with fibers epoxies etc. This work aims at characterization and mechanical properties of polypropylene reinforcement with aluminium oxide [7] and nano clay.

Polypropylene homo polymer (PP) with (1110MG, Density 0.903 gm/cm3, MFI 11 gm / 10 min) supplied by Indian Oil Corporation Limited is selected as matrix.

The aluminium oxide can be obtained from the aluminium dross which is a residue from the primary and secondary aluminium production by refining. The aluminium dross consists of about 64% aluminium oxide. The aluminium oxide is purchased from Zigma Aldrich, Bombay.

Figure 1: Polypropylene

Figure 2: Aluminium Oxide

15A clay is mainly used and it is natural montmorillonite clay that was organically treated with a quaternary ammonium salt. The nano clay is purchased from Zigma Aldrich, Bombay.

Figure 3: Nano clay

The compound for the specimen is prepared by the melt blending technique. The Aluminium oxide, Nano clay and Polypropylene are mixed in the Twin screw extruder at CBPST, Kochi. The twin screw extruder of model ZV 20, screw diameter of 21 mm and L/D ratio of 40:1 is used for the blending of polypropylene with aluminium oxide and nano clay.

Figure 4. Twin Screw Extruder

The motor and feeder speed of the twin screw extruder is 90 rpm and 18 rpm, motor torque of 16 – 17.6 Nm and 7.3 amps. The melt temperature is 2510C and the melt pressure is 7 bars. The compounds are designated as C110 (A), C130 (B), C131 (D), C132 (D), and C133 (E). The required specimen is prepared by injection moulding machine at CBPST, Kochi as per ASTM standards.

Tensile testing is performed in accordance with ASTM D-638 combined tensile and flexural procedure. Tensile properties indicate the strength of material. It indicates the force needed to pull the specimen apart and also how much material is stretched before it breaks. Charpy impact test, also known as Charpy V-notch test is conducted. The specimens are prepared as per ASTM D- 256 standard.

The impact test strength has been tested in the C.U.S.A.T lab at Kerala. The stress strain curve of the compound is plotted and shown below.

III. RESULTS AND DISCUSSION

The mechanical properties tensile strength, young's modulus, breaking load, ultimate stress and impact energy of various proportions of polypropylene reinforced with aluminium oxide and nano clay have been found out.

The stress strain curve of all the compositions have been drawn and shown below.

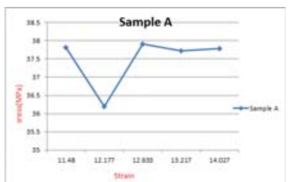

Figure 6. Stress Strain curve of compound A

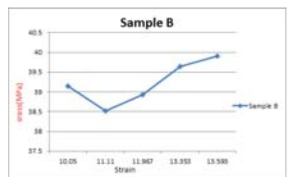

Figure 7. Stress Strain curve of compound B

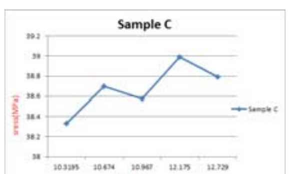

Figure 8. Stress Strain curve of compound C

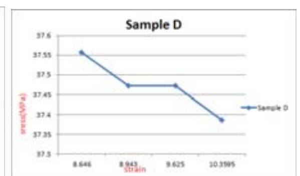

Figure 9. Stress Strain curve of compound D

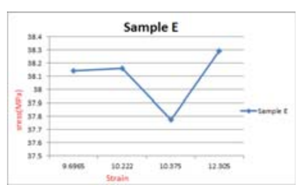

Figure 01. Stress Strain curve of compound E

Table 1 gives the experimental result of ultimate stress, breaking stress, yield stress and young's modulus for various proportions of reinforcement of aluminium oxide and nano clay with polypropylene.

The experiment is conducted on PP, PP+ 3% aluminium oxide + 1 % Nano clay, , PP+ 3% aluminium oxide + 3 % Nano clay and , PP+ 3% aluminium oxide + 5 % Nano clay.

Sample	Maximum Stress (MPa)	Stress at 10% (MPa)	Stress at 20% (MPa)	Stress at 30% (MPa)	Impact Energy (KJ)
PP(A)	37.49152	36.4529	32.2147	NA	66.06
PP+3% Al_2o_3 (B)	39.2277	38.4578	34.7804	NA	59.55
PP+3% Al_2o_3+1% NC(C)	38.67824	38.1882	22.5548	NA	53.93
PP+3% Al_2o_3+3% NC(D)	37.53022	37.166	33.2594	NA	39.74
PP+3% Al2o3+5% NC(E)	38.08348	37.6857	NA	NA	43.84

Table 1. Maximum stress, stress at 10 %, stress at 20 %, stress at 30 % & impact energy of compounds (A, B, C, D &E)

IV. CONCLUSION

There is a minor enhancement of desirable mechanical properties when aluminium oxide and nano clay were added to polypropylene at different percentages. Based on the comparison of the mechanical properties between various proportions of the compound the maximum stress is obtained at the addition of 3% aluminium oxide.

By the addition of nanoclay and aluminiumoxide the impact energy tends to decrease than that of pure polypropylene. This is due to the lack of improper mixing and absence of coupling agent.

By using a suitable coupling agent and using vibration mechanism for achieving a homogeneous composition, better properties can be obtained.

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