Study of the Physical Properties of PET Nanocomposites with and without Comptibiliser

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Abstract- **Polymer nanocomposite is the recent interest to study. In this paper the nano composites of poly (ethylene terpthalate) with three different nano filler. The composite were prepared in melt mixing in corotating twin screw extruder. The samples were prepared with injection moulding. The tensile, flexural and impact properties of the nano composites are tested. This type of composite can be used in packaging field, where transparency required with strength.**

Index Terms -- **Nanocomposite, PET.**

I. INTRODUCTION

Nanocomposite technology is a young material science and plastic nanocomposites are among its first commercial applications. Its products improve barrier, flame resistance, thermal and structural properties of many plastics. They are not only used to improve existing products, but also are extending their reach into areas formerly dominated by metal, glass and wood. Its main focuses may be the appliance, construction, electrical, food packaging and transportation sectors, but unique uses come up almost daily.

The key to the performance of polymer nanocomposites is the quality of dispersion of the nano-reinforcement particles and the interfacial interaction between the matrix and the reinforcement phase. Optimisation of these properties requires various special and complicated treatments, which are not always easy to determine. Often property enhancement is not as significant as expected by the industry for the use of these nanocomposites.

Polyethyleneterapthalate (PET) were compounded with three different nanoclays developed and provided by CSMCRI with proportion of 3 and 5 % with and without using compatibilisers.

Since most polymers are hydrophobic and are not compatible with hydrophilic clays, it is often very difficult to intercalate/exfoliate clay into the polymer matrix. In such cases, pre-treatment of either the clays or the polymers is necessary.

Compatibilisers act through a chemical reaction (Reactive Compatibilisation) or through intermolecular forces of attraction such as Van der Waals, hydrogen bonding, based on polarity of the materials (Non Reactive Compatibilisation).

In addition, a compatibiliser may function by more or less the same mechanism as a surfactant does to stabilize oil/ water mixture, i.e., by being soluble in one or both major components of the blend. One such mechanism is by attaching itself to one of the blend components through chemical grafting and leaving a polymeric "tail" that is soluble in the other component Stabilized, more uniformly dispersed domains result because of reduced interfacial energy between phases.

This work in the nanocomposite area is mostly confined to the laboratory level, where their structure and properties are evaluated at a fundamental level, new compositions can be developed & checked and newer applications can be explored.

II. EXPERIMENTAL

1) Materials

In this study the nano composites were prepared by using three nano fillers with Nylon, polycarbonate and Polyethylene Terpthalate with proportion of 3 % and 5 %.

Three here polymer materials were used in this project work. Nylon (Gujlon) was supplied from Gujarat State Fertiliser Corporation, Baroda. Polycarbonate (PC) (Lexan 143 R) was supplied from Sebic Innovatives Plastics, India, Polyethylene Terpthalate (PET) (G 5801 K) was supplied from Reliance Industries Limited, India. Processing additives Finawax SS and G 748 were purchased form Fine organics, Mumbai for better processibility of above polymers. Processing aid G 748 was added in PET and PC with proportions of 0.3 % and Finawas SS was added in nylon with proportion of 0.3 %.

TABLE I
THE GENERAL PROPERTIES POLYMERS

Properties	Units	PET
Tensile Strength at break	Kg/cm^2	490
Elongation at break	%	30
Flexural Strength	Kg/cm^2	840
Izod Impact Strength	Kg. cm/cm	05

Ref: From company product datasheet

Optim GE 344 grafted comptibilizer purchased from Pluss polymers Ltd., Delhi. Optim GE 344 was used in PET. The characteristics of the comptibilizer is given in Table 2.2

TABLE II
CHARACTERISTICS OF COMPTIBILIZER

Properties	**Units**	**Values of Comptibilizer**	
		Optim E 117	**Optim GE 344**
Density	Gm/ml	0.923	0.87
MFI (190° 2.16 Kg)	Gm/10 min	1.5	5.5
MAH content	%	0.5-0.8	-
Grafted GMA content	%	-	2.0

The nano talc materials were used for the nano composite. These nano fillers were supplied from the CSCMRI, Bhavnagar. Nano clay B1HT.8 made by CSMCRI – Yellow in colour (Nano Filler I), Nano Clay Nanomer 1.44 P, Made by nanomer – off white in colour (Nano Filler II) and Nano Clay B1ODA1.125, made by CSMCRI - Yellow in colour (Nano Filler III). No treatment was given to nanoclay after preparation. The general properties of nano fillers were given in Table 2.3. The particle size was measured by Laser diffraction method on Malvern's Mastersizer 2000 and surface area was measured by BET method using Nitrogen adsorption/ desorption method

TABLE III
THE GENERAL PROPERTIES OF ABOVE NANO FILLERS

Properties	**Value**
Oil Absorption:	100 to 120 % wt/wt.
Particle size:Average particle size	~15 microns and Maximum size is 35 microns.
Bulk density	0..45 to 0.50 cc/g.
Surface area:	~ 5 meter square per gram.

2) Sample Preparation

The above polymer and nano filler were compounded in co rotation twin screw extruder (Steer Engineering make, Model: Omega 30) between temperature range of 245 to 265 temperature. The granual were quenched in water and granulated. The material is dried in vacuum before injection moulding.

All compounding ingredients, such as resin, nanoclay, compatibilizer, and stabilizer can be added into the extruder main feeder. If large amount of filler, For instance, 50% of the fillers needs to be added to the formulation, split feeding of the filler will be required. It can be fed through the main feed, and the rest can be fed from the side feeder.

TABLE IV
THE BATCH DETAIL OF NANO-COMPOSITES WITHOUT COMPTIBILIZER

Batch code	**Filler**	**% of filler**	**Filler (Gms)**	**Polymer (Gms)**
PET 11	Nano filler I	3	90	2910
PET 12	Nano filler I	5	150	2850
PET 21	Nano filler II	3	90	2910
PET 22	Nano filler II	5	150	2850
PET 31	Nano filler III	3	90	2910
PET 32	Nano filler III	5	150	2850

TABLE V
THE NANO-COMPOSITES WITH COMPTIBILIZER

Batch code	**Filler**	**% filler**	**Comptibilizer (gms)**	**Filler (Gms)**
C PET 11	Nano filler I	3	90	90
C PET 12	Nano filler I	5	90	150
C PET 21	Nano filler II	3	90	90
C PET 22	Nano filler II	5	90	150
C PET 31	Nano filler III	3	90	90
C PET 32	Nano filler III	5	90	150

The granuals were injection moulded on an injection moulding machine L& T (PFY40LNC4P). The barrel temperature were 170- 190 ^{0}C from feed zone to nozzle, while mould was at 40 ^{0}C. The mould temperature was normal in nylon, while 70 for PET and PC.

Compounded nanocomposite granules should be added at the typical temperature setting by using recommended temperature setting of base material. The temperature range should be such to prevent thermal degradation of the products. Moderate back pressure is recommended. In addition, it should be processed with low moisture content, predrying is necessary for Polycarbonate.

The injection moulded samples as per ASTM tested for mechanical properties.

3) Testing

3.1)Tensile and Flexural Properties

Tensile properties and flexural properties were measured at room temperature according to ASTM standard ASTM D 638 test method using dumb- bell shaped test specimens using a universal testing machine (Lloyds). The cross head speed was 50 mm/ min, while gauge length was 65 mm.

3.2) Izod Impact Strength

The notched izod impact property was measured on impact machine (Ceast make) according to ASTM D 256 test procedure. Atleast five samples were tested at each blend composition and the average value is reported. The tests were performed at room 25^0 C.

III. RESULTS & DISCUSSION

1) Pet Composite

The mechanical properties of polyethylene terpthalate (PET) nanocomposites with and without using comptibilizer were observed.

TABLE VI
THE MECHANICAL PROPERTIES OF PET NANO COMPOSITE WITH AND WITHOUT USING COMPTIBILIZER.

PET nano composite without comptibilizer				PET nano composite with comptibilizer			
Impact Strength (J/m)							
Filler in %	**Nano Filler1**	**Nano Filler2**	**Nano Filler3**	**Filler in %**	**Nano Filler1**	**Nano Filler2**	**Nano Filler3**
0	5	5	5	0	5	5	5
3	36.87	40.8	36.555	3	41.748	40.938	44.844
5	36.525	33.435	23.84	5	47.5	62.813	31.7165
Tensile Strength at break (N/mm^2)							
0	48	48	48	0	48	48	48
3	38.808	25.160	33.939	3	51.762	51.247	51.364
5	25.426	56.602	31.226	5	58.132	50.161	38.090
Tensile Elongation at Break (%)							
0	30	30	30	0	30	30	30
3	3.261	2.612	3.250	3	6.162	4.460	4.386
5	2.102	7.276	2.991	5	5.401	6.754	3.392
Flexural Strength (N/mm^2)							
0	82.380	82.380	82.380	0	82.380	82.380	82.380
3	83.032	80.163	88.505	3	81.280	81.452	77.248
5	91.159	81.385	77.834	5	82.254	80.588	54.653

2) Impact Strength

The impact strength of the nanocopmposite increases with addition of all type of nano filler upto 3% addition. The reduction was observed.

The impact strength of the nanocomposites with comptibilized is shown in graph. The impact strength of all nanocomposites increases with addition of the nano filler. The value of the comptibilised nanocomposites was higher than the without comptibilizer. In the case of nanocomposites with nanofiller 2 increases with addition of filler.

3) Tensile Properties

3.1) Tensile Strength

The tensile strength of the PET nanocomposites is shown in graph 3.19. The strength is decreases in composite with nano filler 1 and nanofiller 1and nanofiller 3. The tensile strength of nanocomposites with nano filler 2 decreased at 3 % and increased at 5 % addition of Nano filler.

The tensile strength of PET nano composite with comptibilizer increased with nano filler 1 and decreased with nanofiller 3 addition with minor variation.

3.2) Tensile Elongation at Break

The tensile elongation at break decreased drastically with addition of all types of nano fillers. In both cases with comptibilizer and without comptibilizer, similar results were observed.

4) Flexural Strength

The flexural strength of the nanocomposites with nanofiller 1 was increased with addition of filler. The flexural strength of nanofiller 3 was increased at 3 % addition, while decreased with more addition. The little change was observed in nano composite with nanofiller 2. There was not significant changes in flexural strength of the nanocomposites with comptibiliser as shown in graph 3.24.

IV CONCLUSION

Remarks on effect of Nano clays on various polymers without using compatibiliser.

The rise in impact strength was observed for with addition of the all types of nanofillers. The impact strength was better with nanofiller 2. The impact strength was better with addition of comptibiliser.

The tensile strength was increased with the nanofiller 2. While with other two nanofillers the tensile strength is decreases. The tensile strength increases with addition of comptibiliser.

In all nanocomposites the tensile elongation was reduced and effect on flexural strength was very little in both cases with and without comptibiliser.

V REFERENCES

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