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SPECTROSCOPIC STUDIES OF NANOCOMPOSITES BASED ON IMPACT MODIFIED PBT/PTT BLENDS LOADED BY ORGANOCLAY

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ABSTRACT

Novel nanocomposites of PBT/PTT loaded by different contents of organoclay were prepared via melt intercalation. Ultra low density polyethylene grafted glycidyl methacrylate (ULDPE-g-GMA) was used as an impact modifier to toughen the polymeric matrices (PBT and PTT). In all the prepared nanocompositions the amount of impact modifier (ULDPE-g-GMA) remains constant i.e. 2 wt %. The microstructure analysis of nanocomposites was carried out by using FEG-SEM, XRD and polarizing optical microscopy (POM). SEM micrograph of the fracture surface of PBT/PTT blend and a nanocomposite with 3 wt% organoclay in PBT/PTT/2wt% ULDPE-g-GMA did not show phase separation. It indicated that 3 wt % organoclay was homogeneously dispersed in impact modified PBT/PTT blends based nanocomposites and impact modified PBT nanocomposites. POM studies showed that the well defined spherulites were seen in neat PBT and neat PTT when T_c was 205 °C. In the case of nanocomposites, spherulites size was smaller because organoclays behaves as a nucleating agent which increased the nucleation density in the polymer matrix. Spectroscopic results indicated that nanocomposite preparation requires sufficiently hydrophobic organically modified layered silicates (organoclay) and the presence of polar type interactions between the silicate layer and polymer matrix. FT-IR analysis of PBT/PTT blends and nanocomposites indicated that no extra peak appeared in graph. It showed that no chemical transesterification reaction occurred between these two polymers. Based on these results it can be justified that the reaction takes place between impact modifier, organoclays and polymeric matrix. The prepared nanocomposites are very useful in various technical engineering applications.

Keywords: FT-IR; Nanocomposites; PolyButyleneTerepthalate; POM; PTT; Spectroscopy; XRD.

I. INTRODUCTION

Polymer morphology is a well established and rapidly growing branch of materials science. It is the study of order within macromolecular solids but, in a wider context, it also embraces the processes of formation (crystallization, deformation, etc.) and the structural consequences for the chemical and physical properties. The study of polymer morphology is the record of past history of a sample, not limited only to crystallization, annealing or deformation but can also provide an indication of certain intrinsic properties of polymers such as molecular mass range within the specimen or the nature and extent of molecular branching [1]. Morphology of polymeric blends and nanocomposites depends mainly on rheological properties and interfacial interaction between the components, blending conditions and volume ratio of the components [2, 3]. The preparation of polymer clay nanocomposites by melt intercalation process can be obtained by effectively matching the surface polarity of clay with polymer polarity, so that good interactions occurs between organoclay and the polymer matrix [4]. In order to form polymer nanocomposites, the polymer has to fully wet and intercalate between organoclay tactoids [5]. The compatibility and maximum interactions between polymer matrix and surface modification of silicate layers are very important for the formation of intercalated and especially exfoliated polymer layered silicate (PLS) nanocomposites [6]. X-ray diffraction (XRD) technique has been widely used for the characterization of polymer clay nanocomposites. Fourier transform infrared (FTIR) spectroscopy has been used to determine the structure of nanocomposites. XRD allows the precise measurement of clay layer spacing and intercalation behaviour of polymer –clay nanocomposites [7, 8]. Any possible interaction between nanoclay and polymers at the surface was elucidated by Fourier transform infrared spectroscopy.

Various studies conducted by various scientist show that the property enhancement of polymer clay nanocomposites are influenced extensively by the dispersion of clay in the polymeric matrix [9-11]. Vaia et al. [12] studied that the interaction between polymer and MMT played a key role in the melt intercalation process, whereas a high mixing temperature was not helpful to the decrease of the Gibbs free energy of the intercalation process. Balazs et al. [13] observed the effects of the polymer-MMT interactions on the melt intercalation process. They concluded that strong interaction was useful to the intercalation process; it showed negative effects on the exfoliation process.

Liu et al. [14] have examined the effect of OMMT types and its loadings on the morphology, thermal stability, and mechanical properties of PTT/MMT nanocomposites. They found that different types of OMMT led to different morphologies (intercalation or exfoliation) of the nanocomposites. Acierno et al. [15] have studied the relationships between hybrid composition, processing conditions, nanoscale morphology and properties of PBT nanocomposites based on number of commercial OMMT at different weight percentages. Chang et al. [16] prepared PBT/organoclay by in situ interlayer polymerization method and investigated the thermo-mechanical properties and the morphology of its fiber. Though, in all cases surface modification of clay is necessary. For the preparation of PBT/clay nanocomposites, high temperature has been required to form homogenously dispersed nanocomposites, because high temperature would induce the decomposition of alkyl ammonium cations in the organic modified clay in melt intercalation and bulk processing [17].

The main aim of this paper is to report the investigations and characterization carried out by X-Ray, FT-IR, POM and FEG-SEM spectroscopy on PBT/PTT blends and impact modified PBT/PTT blends based nanocomposites loaded by different content of organoclay. These all characterization explains the morphological properties of impact modified PBT and PTT, PBT/PTT blends and nanocomposites based on impact modified PBT/PTT blends. The morphology and microstructure of polymer/clay nanocomposites are typically elucidated by FEG-SEM, XRD and optical microscopy. Scanning electron micrographs explain the interfacial interaction between the filler (organoclay) and the polymeric matrix . XRD and FT-IR is used to determine the structure of nanocomposites.

II. EXPERIMENTAL

2.1 Materials

- PBT (T06 200) obtained from DSM Engineering Plastics (Pune, India). It has melting temperature (T_m) is 223 °C and having density 1.3 g/ml.
- PTT (Futura CPTT) obtained from Futura Polymers. Ltd., Chennai, India. It has a melting temperature (T_m) of 227 °C and having density 1.3 g/ml.
- Organoclay genereously supplied by Southern Clay Product Inc. under the trade name Cloisite 30B, modified with methyl, tallow, bis-2-hydroxy ethyl ammonium.
- Ultra low density polyethylene grafted glycidyl methacrylate (ULDPE-g-GMA) (trade name GE-344) which contained 2 % grafted GMA was used as Impact modifier and supplied by Pluss Polymers, India.

2.2 Sample Preparation

PBT/PTT blends and impact modified PBT/PTT blends based nanocomposites were prepared via melt intercalation by using co-rotating Twin Screw Extruder (TSE). Prior to melt mixing both the PBT and PTT pellets and OMMT were dried under vacuum oven at 80 ^{o}C for 10 hr. Impact modifier (IM) ULDPE-g-GMA was used as received and the screw speed was set at 70 rpm. The dried samples were then melt blended in the respective extruders maintaining a temperature profile of 210°C to 260 $^{\circ}$C. The extruded strands were quenched immediately in a water bath kept at room temperature. The compositions obtained were collected as strands, which were chopped into granules and dried before any further processing.

The compositions were prepared by one step process technique of melt compounding. The details of compositions prepared using twin screw extruder and microcompounder are given in **Table 1** and **Table 2**.

Table 1. Sample identification and composition of PBT/ PTT blends

Sample code	Composition (wt %)	
	PBT	**PTT**
BL A	25	75
BL B	75	25
BL C	50	50

BL- Blend

Table 2. Sample identification and composition of impact modified blends based nanocomposites (*N- Nanocomposites)

Sample Code	Composition (wt %)			
	PBT	**PTT**	**ULDPE-g-GMA (IM)**	**OMMT**
*NA1	23	73	2	2
NA2	22.5	72.5	2	3

NA3	21.5	71.5	2	5
NB1	48	48	2	2
NB2	47.5	47.5	2	3
NB3	46.5	46.5	2	5
NC1	73	23	2	2
NC2	72.5	22.5	2	3
NC3	71.5	21.5	2	5

2.3 Characterization

2.3.1 **X-ray Diffraction (XRD)**

Wide-angle X-ray diffraction (WAXD) studies were carried out on a Philips X-Pert Pro. The incident X-rays (λ=1.54 Å) from the Cu-target were monochromatized using a Ni filter. WAXD patterns were recorded with a step scan with step size of 0.02 between 5º and 40º (2θ).

2.3.2 **Fourier Transform Infra-red Spectroscopy (FT-IR)**

Fourier transform infrared (FTIR) spectroscopic analysis was carried out with Nicolet, MAGNA 550 for powder samples using potassium bromide (KBr) pellets in the scanning range of 400 to 4000cm^{-1}.

2.3.3 **Polarizing Optical Microscopy (POM)**

The spherulite formation was studied by using Zeiss Axioscope polarizing optical microscope using 10 times magnification. POM experiments were carried out by heating pellets to 260 ^{o}C and hold the sample for 3 min for complete melting. Melt sample was cooled to 205 ^{o}C and kept at this temperature for 30 min. The crystallization of polymer was observed during cooling process.

2.3.4 **Field Emission Gun Scanning Electron Microscopy (FEG-SEM)**

Morphological analysis was carried out by using **FEG-SEM** (JEOL JSM-7600F) on cryogenically fractured surfaces of injection molded samples. The tensile samples were kept in liquid nitrogen for half an hour and then they were fractured cryogenically. The fractrured surfaces were then coated with gold and examined by FEGSEM.

III. RESULTS AND DISCUSSION

3.1 X-ray Diffraction (XRD)

XRD tool is commonly used to determine the structure of polymer clay nanocomposites. By observing the position of peak, shape, and intensity of the basal reflections from the distributed silicate layers, the nanocomposite structure (intercalated or exfoliated) may be identified. It is a convenient way to determine the interlayer spacing of silicate layers in the pristine clay and in intercalated polymer layered silicate nanocomposites [18, 19]. It allows the accurate measurement of silicate layer spacing and intercalation behaviour of nanocomposites [7, 8, 20]. The XRD patterns of neat PBT, neat PTT and impact modified PBT and PTT are presented in **Fig. 1**. X-ray diffraction patterns of neat PBT and neat PTT did not show any change on the addition of 2 wt% impact modifier (ULDPE-g-GMA) and remain located at the same 2θ values. There is no

X-ray diffraction peak at the low 2θ range (1°–10°). It is observed that XRD patterns of neat PBT, neat PTT and impact modified PBT, PTT (98/2 PBT/IM, 98/2 PTT/IM) have not shown any new characteristic peak shift in **Fig. 1**. It indicates that the existence of ULDPE-g-GMA (IM) has no effect on the crystalline form of PBT and PTT [21]. It has also been found that in the presence of ULDPE-g-GMA (IM), the crystalline structure of neat PBT and neat PTT in the impact modified PBT and PTT remained same.

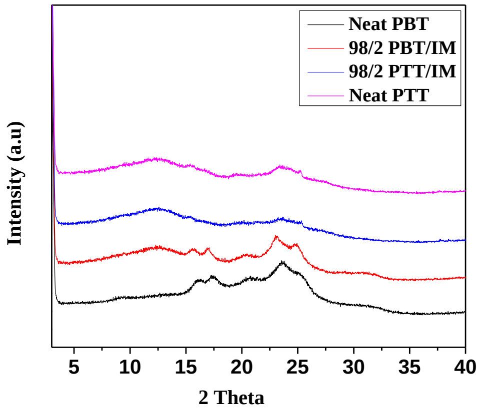


Fig. 1 XRD patterns of neat PBT, neat PTT and impact modified PBT and PTT

X-ray patterns of the PBT/PTT blends are given in **Fig. 2**. X-ray patterns of the blends shows that there are no additional peaks and shifts in the position of peaks. It reveals that the PTT and PBT components in the blends crystallized separately to form its own crystallite [22, 23]. The peaks of the blends are almost similar to those of neat PBT and neat PBT when PBT or PTT, either of them is the major component (more than 50%). 50:50 PBT/PTT blend shows broader peaks, indicated that the crystals are smaller and imperfect. Similar results were observed by Supaphol et al. [22] for PET/PTT blend.

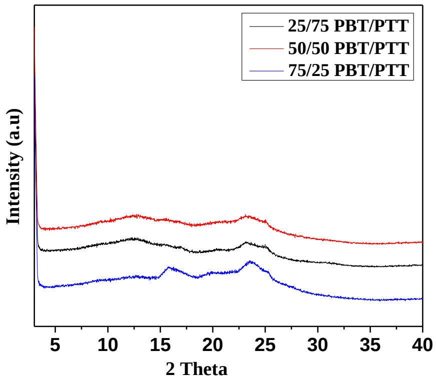
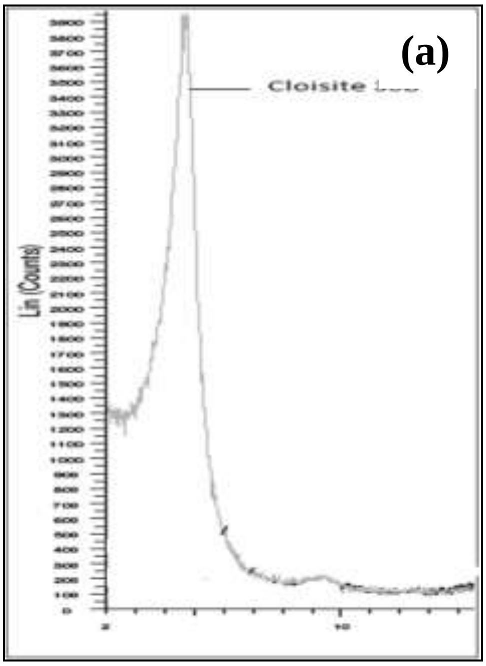


Fig. 2 XRD patterns of PBT/PTT blends

In nanocomposites system, XRD technique is widely used to observe the dispersion of organoclay in polymer matrix. It is important to note that the surface polarities of polymer and organoclay should be matched in order to fully wet the polymer and intercalate in the organoclay layers [5, 24, 25]. Polar type interactions are very important for the formation of intercalated and especially exfoliated nanocomposites by polymer melt intercalation [12, 24]. Organic modification of clay increased the basal layer spacing of clay and therefore, hydrophobic, organophilic surface of clay becomes more compatible for the polymer to enter between the silicate layers (referred to as the *gallery*) of the clay [26, 27]. Nanoscale dispersion of the clay in the polymeric matrix has been described by the d spacing of XRD patterns [28]. In, *Immiscible* polymer nanocomposites there is no any change in *d*-spacing, it means that no polymer has entered between the silicate layers and hence, the spacing between clay layers remains unchanged. *Intercalated* nanocomposites show an increased *d*-spacing, indicating that polymer has entered the gallery, expanding the layers. XRD of *Exfoliated* nanocomposites show no peak. It suggest that a great amount of polymer has entered the gallery space, expanding the clay layers so far apart that diffraction cannot be observed by XRD techniques [4, 25, 28-30].

Fig. 3 (a, b, c and d) shows the XRD results of the impact modified PBT/ PTT organoclay nanocomposites as well as the Cloisite 30B (organoclay). XRD of Cloisite 30B shows a diffraction peak at $2\theta = 4.73$ °C which corresponds to an interlayer spacing of 1.89 nm as shown in **Fig. 3 (a)**, indicated that it has a large content of organic surfactant in its galleries. Intercalation process is also influenced by other parameters such as the processing conditions [15, 31, 32] and the molecular weight of the matrix [9, 33]. Wide d-spacing of clay, makes the polymer chains to penetrate easily between the clay layers. This is responsible for the high degree of exfoliation of the nanocomposites. Generally, larger silicate layer spacing can be advantageous for the increase of clay dispersibility in a matrix due to decrease in the silicate-silicate attraction. This result can be reasonably described by the fact that clay dispersibility depends on the density, length, and type of the surfactant modifier [34, 35**]**.

The XRD patterns of impact modified PBT/PTT blends based nanocomposites show that the characteristic peak of the Cloisite 30B disappeared at lower 2θ values as shown in **Fig. 3 (b, c and d)**. The absence of the characteristic peak of the organoclay in impact modified PBT/PTT blends indicated that the clay platelets are completely exfoliated. Vain et al. [7] and Galgali et al. [36] observed featureless XRD patterns for partially exfoliated nanocomposites. Due to the presence of hydroxyl groups, the methyltallowbis-2-hydroxyethyl ammonium cation present in Cloisite 30B (organoclay), interlayer has strong polar interaction with the carboxyl groups present in PBT and PTT, favouring the intercalation of PBT and PTT chains and the formation of PBT/ PTT organoclay nanocomposite [4, 24, 37]. It has been considered that the interaction via hydrogen bonding between the amine group of the intercalant in the Cloisite 30B (organoclay) and glycidyl methacrylate (GMA) group of ULDPE-g-GMA would assist dispersion of organoclay in nanosize in the PBT/PTT blends. It has been reported that clay particles were highly dispersed in polymeric matrix without large agglomeration at low organoclay content (1-5 wt %) [38].


(a)
Cloisite
Lin (Counts)
3900
3800
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
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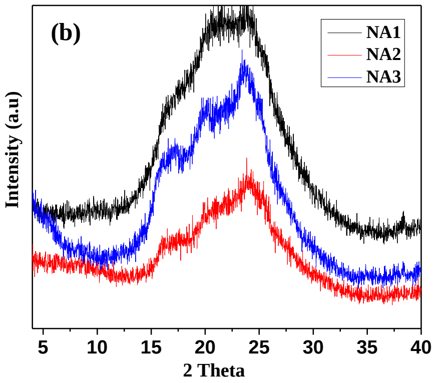
2
10


(b)
NA1
NA2
NA3
Intensity (a.u)
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10
15
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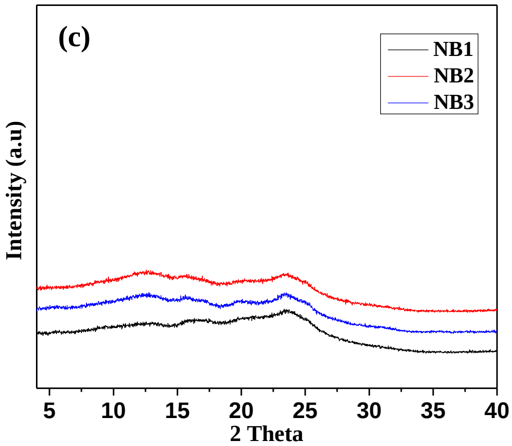
25
30
35
40
2 Theta


(c)
NB1
NB2
NB3
Intensity (a.u)
5
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35
40
2 Theta

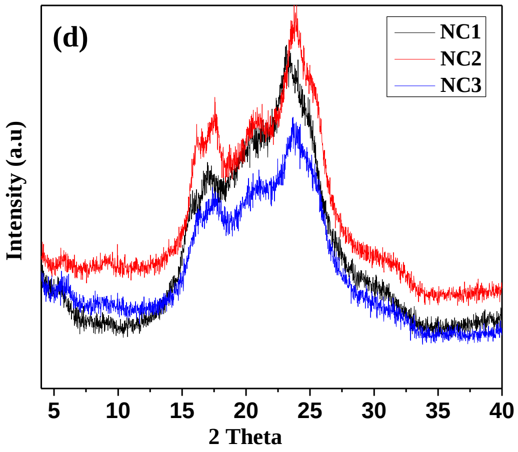


Fig. 3 XRD patterns of (a) organoclay (Cloisite 30B) and impact modified PBT/PTT blends with 2, 3 and 5 wt % organoclay (b) 25/75 PBT/PTT, (c) 50/50 PBT/PTT, (d)75/25 PBT/PTT

3.2 Fourier Transform Infra-red Spectroscopy (FT-IR)

FT-IR spectroscopy is used to determine the vibrational stretching frequency of functional groups. The absorption band for PBT and PTT appears at about 1720 cm^{-1}, representing the free carbonyl (>C=o) stretching vibration peak. Peak at 2960-2967 cm^{-1} indicates the stretching frequency of CH_2 bonds. This peak is a characteristic peak of polyester.

Fig. 4 shows the FT-IR spectra of neat PBT, neat PTT and impact modified PBT and PTT. As shown in **Fig. 4**, the spectrum of PBT is characterized by the following peaks: ν(O-)CH2 at 2961 cm^{-1}, ν(CH2-)CH2 at 2925 and 2854 cm^{-1}, ν(C=O) at 1711 cm^{-1}, ν[C(=O)-O] at 1270 cm^{-1}, ν(O-CH2) at 1102 cm^{-1}, ν(ring) at 1017 cm^{-1}, and λ(CH aromatic) at 728 cm^{-1}. However, the stretching vibration peak at 1711 cm^{-1} is sensitive to the degree of crystallinity of PBT [39, 40]. The spectrum of PTT has been characterized by the same peaks as shown in PBT spectrum. The absorption bands of IR between 1750–800 cm^{-1} is helpful to estimate the fraction of the crystalline phase of PTT samples.

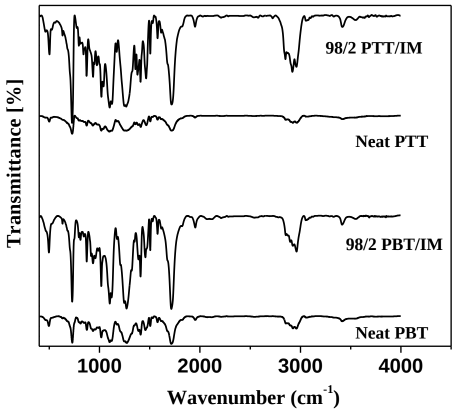


Fig. 4 FT-IR spectra of neat PBT, neat PTT and impact modified PBT and PTT

FT-IR spectra of PBT/PTT blends, and impact modified PBT/PTT blends based nanocomposites are shown in **Fig. 5 and 6 (a, b, c)**. It can be seen that the all the spectra shows the same peaks. Moreover, the positions of the peaks are same in all spectra. It indicates that no major change of the chemical nature on the compositions occurred during processing [37]. There is only a change in the intensity of peaks. The intensity of bands of impact modified PBT and PTT, PBT/PTT blends and PBT/PTT blends based nanocomposites in FT-IR spectra is higher than that of neat PBT and neat PTT. It implies that a reaction takes place between impact modifier, organoclay and polymeric matrix.

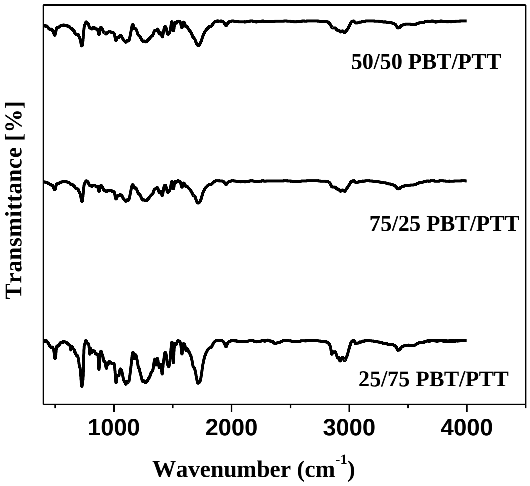
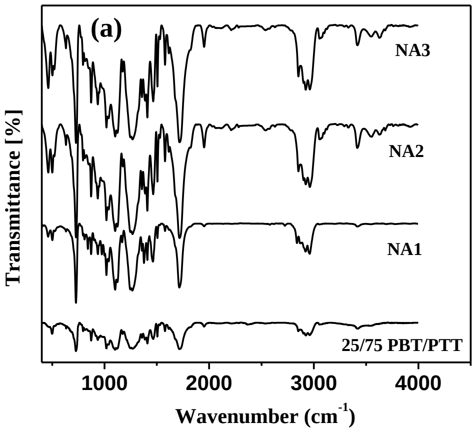
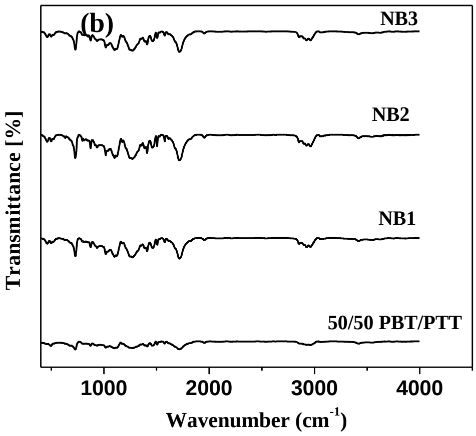


Fig. 5 FT-IR spectra of PBT/PTT blends





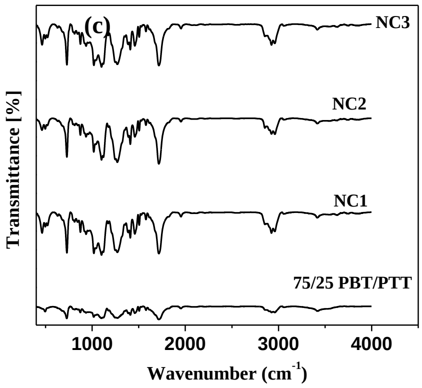


Fig. 6 FT-IR spectra of impact modified PBT/PTT blends based nanocomposites (a) 25/75 PBT/PTT, (b) 50/50 PBT/PTT and (c)75/25 PBT/PTT

3.3 Polarizing Optical Microscopy (POM)

Polarizing optical microscope is equipped with crossed polarizer. The polarizer is located in front of the specimen stage and the analyser, is located behind the objective. The light entering the specimen is linearly polarized. [41]. Superstructures (spherulites, axialites etc.) present in semicrystalline polymers are conveniently examined with polarized optical microscopy.

3.3.1 POM studies of neat PBT, PTT and impact modified PBT and PTT

Fig. 7 (a, b, c and d) gives the POM micrographs of neat PBT, neat PTT and impact modified PBT and PTT (98/2 PBT/IM, 98/2 PTT/IM), isothermally crystallized from melt at 205 °C for 30 min. On cooling, neat PBT, PTT, impact modified PBT and PTT, and PBT/PTT blends forms spherulites as seen in optical micrographs. Spherulites are little spheres, with diameters usually in the range 0.5-100 µm. This is the characteristics of polymers which crystallized from the melt in the absence of significant flow of stress [1]. The well defined spherulites have been seen in neat PBT and neat PTT. The morphology of neat PBT exhibit a typical Maltese-cross spherulite with a fibril pattern [42, 43] as shown in **Fig. 7 (a)**. POM micrograph of PTT **(Fig. 7 b)** shows the formation of banded spherulites. Banded spherulites formation in PTT is due to chain twisting in the lamellar crystals. The formation of banded spherulites in PTT is in agreement with the results reported by P.D.

Hong et. al [44]. The analysis of the POM image shows that the formation of banded structure is dependent on the isothermal crystallization temperature and as the isothermal crystallization temperature increases from 210 to 215 °C, the banded structure disappears [45]. The presence of 2 wt% ULDPE-g-GMA (impact modifier, IM) did not show significant effect on the spherulitic morphology of neat PBT and neat PTT, as shown in F**ig. 7 (c, d)**.

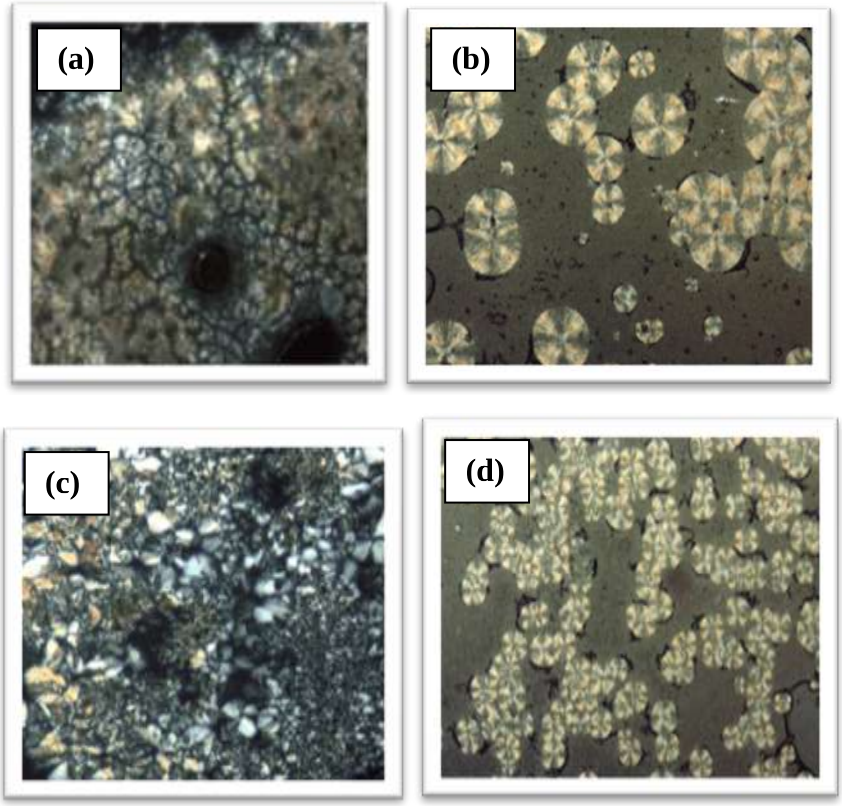


Fig. 7 Optical micrographs of (a) Neat PBT, (b) Neat PTT, (c) 98/2 PBT/IM and (d) 98/2 PTT/IM at 10X magnification, (IM=ULDPE-g-GMA)

3.3.2 POM studies of PBT/PTT blends

Fig. 8 (a, b, c) shows the POM micrographs of PBT/PTT blend. All of the blend systems show spherulite structures. Banded spherulites have been observed for PTT/PBT blends at crystallization temperature range from 190 °C to 210 °C for PTT, PBT and their blends [46]. POM micrograph of 50/50 PBT/PTT blend relatively has bad defined spherulite texture as comparison to 25/75 PBT/PTT and 75/25 PBT/PTT blends. Previous studies showed when two components of any polymers gradually approached each other in weight, the spherulite size gradually diminished [23]. The Maltese cross extinction patterns have been observed in the blend, but the formation was not clear and the number of spherulites increased, which could be assumed that one of the polymer component in blends exhibit nucleation effect on the other [23, 46]. When one of the two components of polymer blend is the major component, the spherulite growth is perfect, exhibiting Maltese cross extinction patterns, as in **Fig. 8 (a and b).** Therefore, 25/75 PBT/PTT and 75/25 PBT/PTT blends shows little bit of perfect spherulite formation.

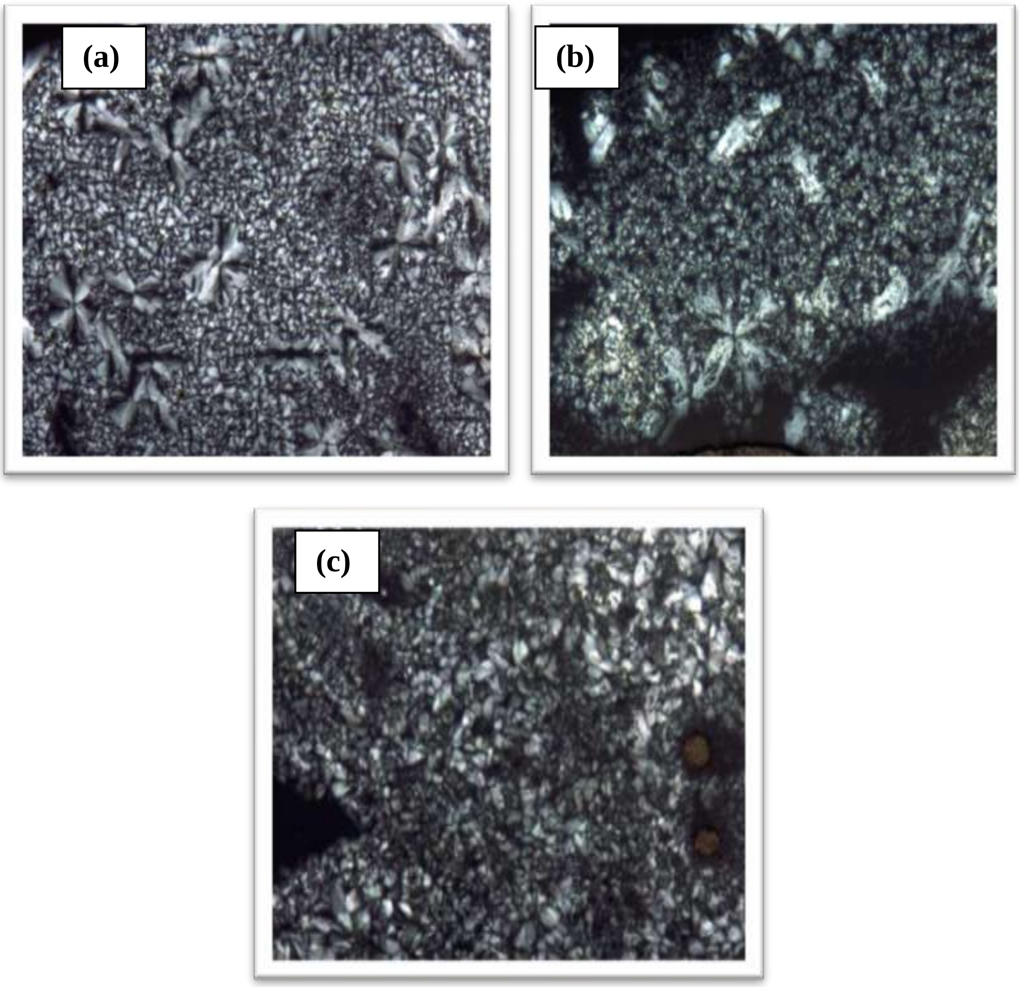


Fig. 8 POM micrographs of PBT/PTT blends (a) 25/75 PBT/PTT, (b) 50/50 PBT/PTT and (c) 75/25 PBT/PTT at 10X magnification

3.3.3 POM studies of impact modified PBT/PTT blends based nanocomposites

The spherulite morphology of impact modified PBT/PTT blends based nanocomposites are shown in **Fig. 9 (a, b, c), 10 (a, b, c)** and **11 (a, b, c)** with 2, 3 and 5 wt% organoclay (Cloisite 30B), during an isothermal crystallization process at 205 °C.

Morphology of impact modified PBT/PTT blends based nanocomposites are quite different from that of neat PBT and neat PTT. POM micrograph of NA3 composition having 5 wt% of organoclay indicate that the dimension is smaller and the degree of perfection of crystallites is less, as shown in **Fig. 9 (c)**. Impact modified 50/50 PBT/PTT blends based nanocomposites (NB compositions, **Fig. 10**) shows the uniform microcrystallites in irregular shape. This result implied that presence of organoclay particles in 50/50 PBT/PTT blend develops many more nucleating centers and disturbs the normal growth of crystallites. Under POM observation, only uniform microcrystallites in irregular shape could be seen. The presence of organoclay particles affected the spherulite form as heterogeneous nucleation. It acts as a nucleating agent in PBT/PTT blends, increasing the nucleation density in polymer matrix, which has been reported by some other researchers [43, 47]. In nanocomposites, a large number of nuclei generated from the nucleation agents simultaneously and grow in a limited space and lead to the formation of smaller spherulites.

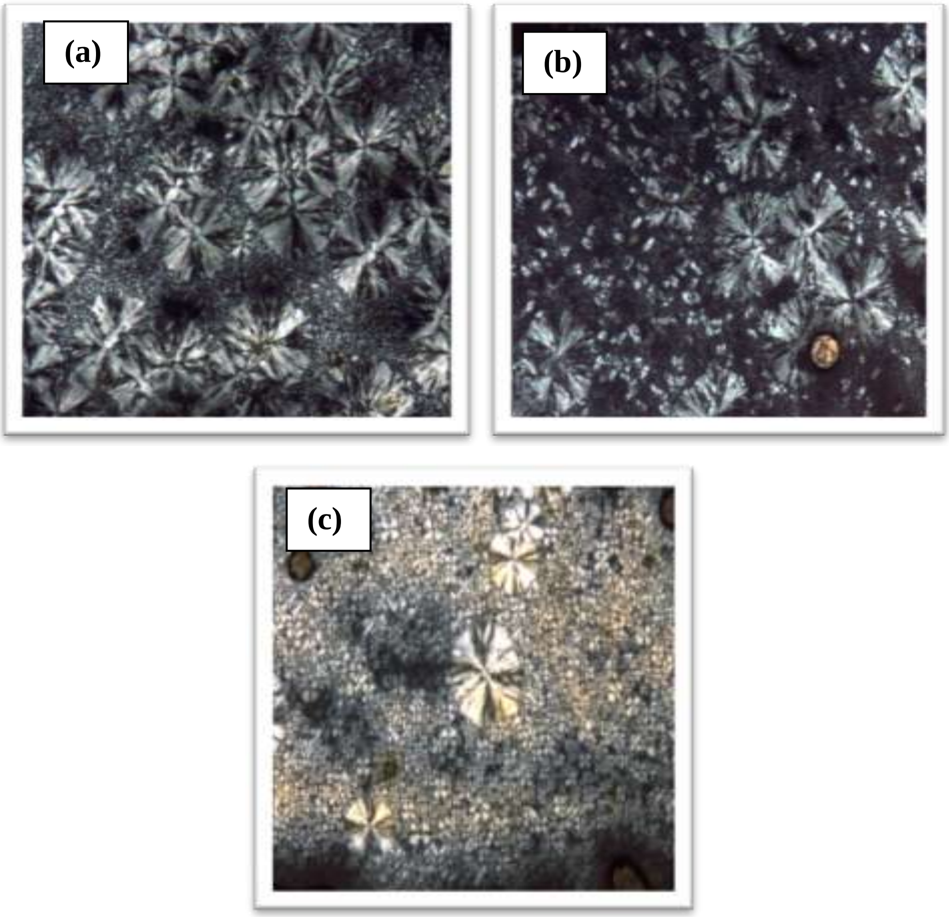
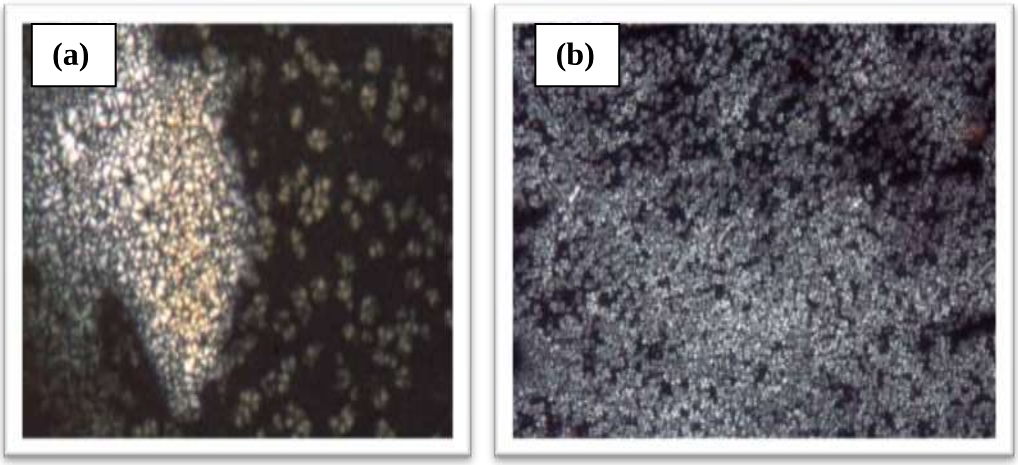


Fig. 9 POM micrographs of impact modified 25/75 PBT/PTT blend with (a) 2 wt%, (b) 3 wt% and (c) 5 wt% organoclay nanocomposites, isothermally crystallized at 205 °C at 10X magnification



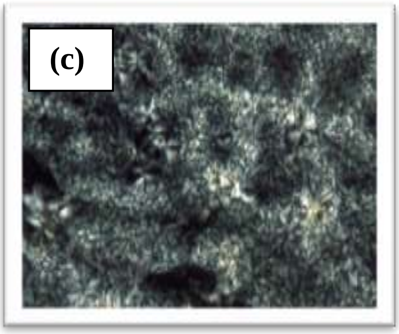


Fig. 10 POM micrographs of impact modified 50/50 PBT/PTT blend with (a) 2 wt%, (b) 3 wt% and (c) 5 wt% organoclay nanocomposites, isothermally crystallized at 205 °C at 10X magnification.

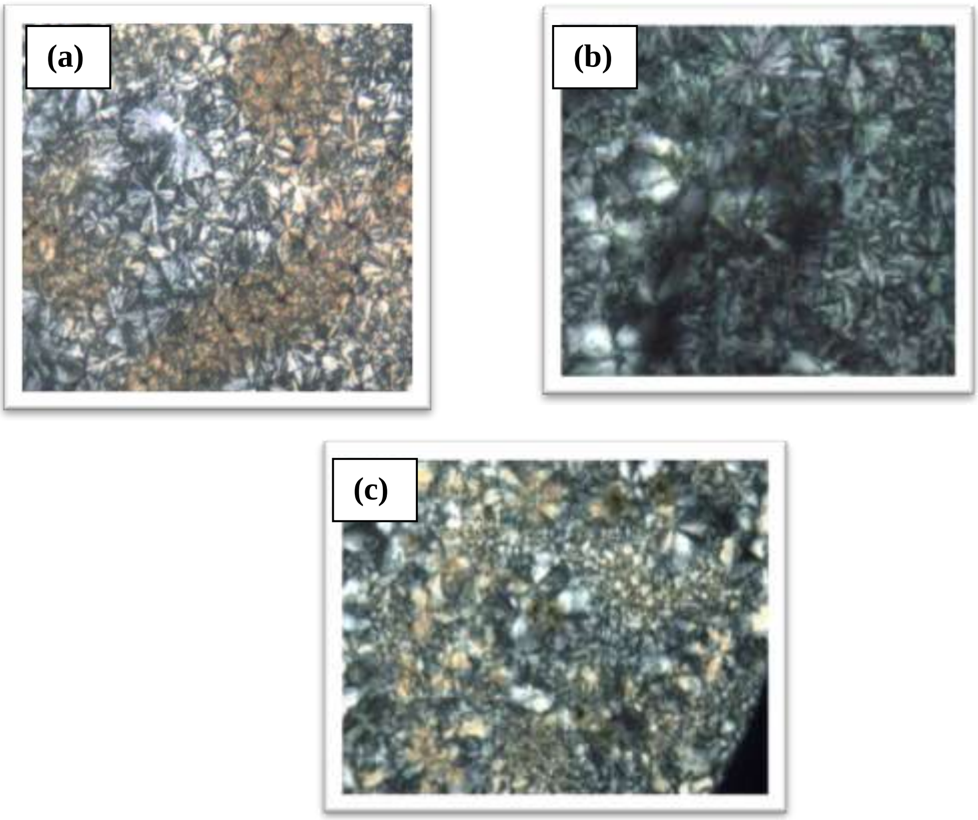


Fig. 11 POM micrographs of impact modified 75/25 PBT/PTT blend with (a) 2 wt%, (b) 3 wt% and (c) 5 wt% organoclay nanocomposites, isothermally crystallized at 205 °C at 10X magnification

3.4 Field Emission Gun - Scanning Electron Microscopy (FEG-SEM)

SEM provides information about the topography of a polymeric specimen and gives detailed topographical images. The SEM images have been obtained by recording the scattered secondary electrons. The depth of field is very large and sharp images can be produced for polymeric specimens with large topographical variations [41]. By studying the mechanical properties of all the nanocomposites it has been found that compositions having 3 wt % of organoclay shows higher value of tensile modulus and strength. An increase in the tensile strength and tensile modulus result from the incorporation of organoclay which stiffens the matrix. Addition of 3 wt% organoclay in NA2, NB2 and NC2 increased the tensile modulus by 41.3%, 24.6% and 34.8%, relative to BL A, BL B and BL C blends, respectively. Since, mechanical properties of 3 wt % of organoclay have shown better results with impact modified PBT/PTT blends, so FEG-SEM analysis has been performed on the same compositions (NA2, NB2 and NC2). In general, the mechanical properties of elastomer/ thermoplastic blends and nanocomposites depend on the morphology and interfacial adhesion between the polymeric matrix, elastomer and organoclay [48].

Fig. 12 (a, b, c and d) shows the SEM micrographs of neat PBT, neat PTT and PBT/PTT blends (25/75 PBT/PTT and 50/50 PBT/PTT). The SEM pictures show the complete homogeneity and continuous phase morphology in the fractured surfaces of the quenched PBT/PTT blends. All evidence discussed above indicates a total miscibility of PBT/PTT blends in amorphous state at all compositions as shown in **Fig. 12 (c and d).**

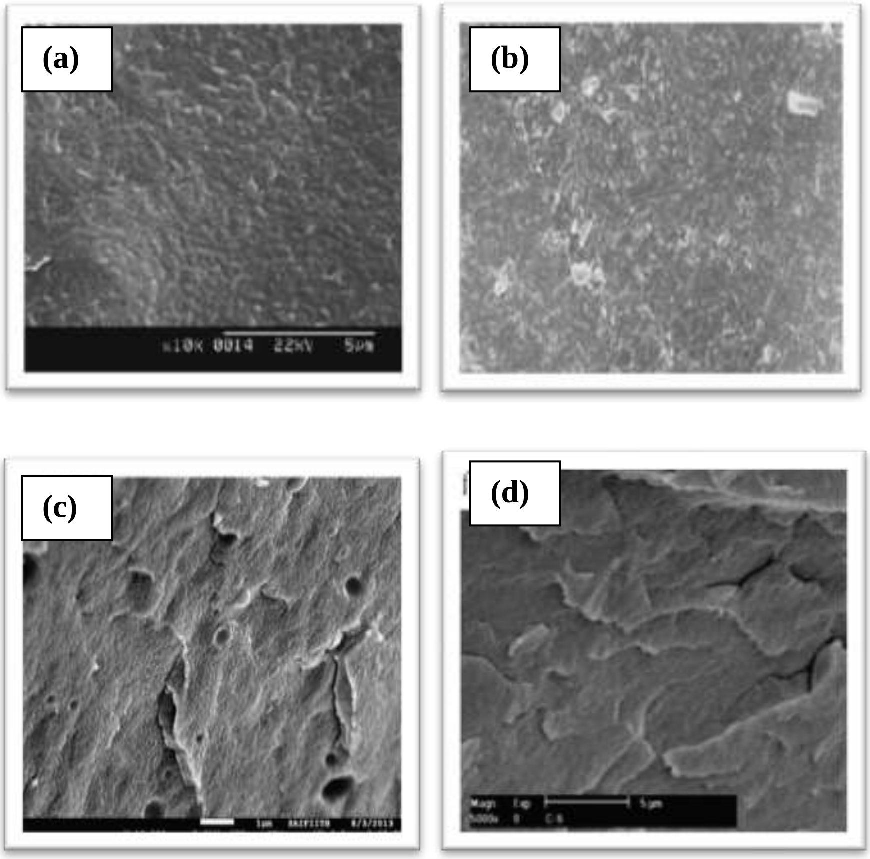


Fig. 12 SEM micrographs of (a) neat PBT, (b) neat PTT, (c) 25/75 PBT/PTT blend and (d) 50/50 PBT/PTT blend

Fig. 13 (a, b, c) is a SEM micrographs of the fracture surface of impact modified PBT/PTT blends based nanocomoposites with 3 wt% organoclay. It seems in the micrographs that the OMMT layers (as indicated by the black arrows) are dispersed uniformly within PBT/PTT blends. Moreover, the sphere-like shape of the polymer nanocomposites with 1% clay or at low clay loadings changed to a partially cylindrical morphology at higher clay contents [49].

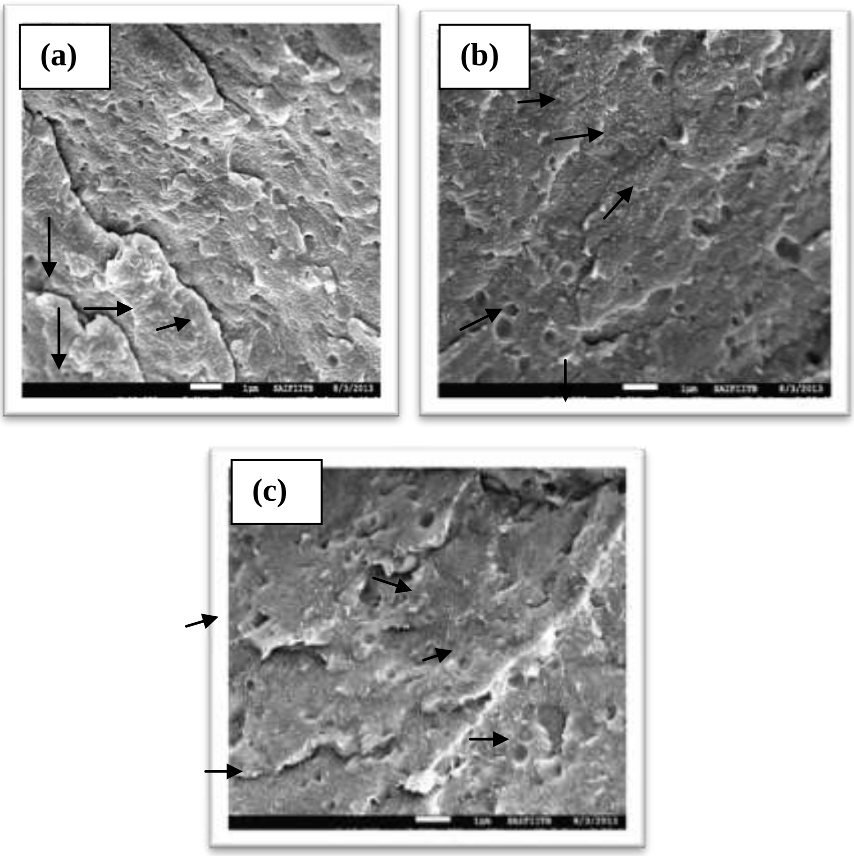


Fig. 13 SEM micrographs of impact modified PBT/PTT blends based nanocomposites with 3 wt% organoclay (a) 25/75 PBT/PTT (NA2), (b) 50/50 PBT/PTT (NB2) and (c) 75/25 PBT/PTT (NC2) blends

IV. CONCLUSIONS

In this paper, FT-IR, XRD, POM and FEG-SEM studies of PBT/PTT blends and nanocomposites have been investigated.

- XRD patterns indicated that the clay particles were fully exfoliated in the PBT/PTT blends.
- POM showed that in nanocomposites spherulites size were smaller because organoclay acts as a nucleating agent, increasing the nucleation density in the polymer matrix. Uniform microcrystallites in irregular shape have been shown by impact modified 50/50 PBT/PTT blends based nanocomposites. Thus, it can be concluded that the presence of organoclay in impact modified 50/50 blends have many nucleating centers as compared to 25/75 PBT/PTT and 75/25 PBT/PTT blends based nanocomposites.
- The morphology of PBT/PTT blends and its nanocomposites was confirmed by FEG-SEM microscopy. FEG-SEM micrographs revealed that the clay layers are uniformly dispersed in PBT/PTT blends.
- FT-IR spectra of impact modified PBT/PTT blends and nanocomposites did not show any extra peak. The position of all the vibrational stretching frequency of functional groups remains same in FT-IR spectrum. Results obtained from spectra showed that intensity of bands of impact modified PBT and PTT, PBT/PTT blends and PBT/PTT blends based nanocomposites in FT-IR spectra was higher than that of neat PBT and

neat PTT. It indicated that a proper reaction takes place between impact modifier, organoclay and polymeric matrix.

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