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Synthesis of Polyvinyl Chloride /MMT Nanocomposites and Evaluation of their Morphological and Thermal Properties

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Abstract - In this priject, polyvinyl chloride (PVC) /montmorillonite nanocomposite has been prepared by melt blending process. For this purpose montmorillonite (MMT) was modified by cetyltrimetyl ammonium bromide (CTAB) as a quaternary ammonium salt and called organo clay (OMMT). Then PVC/ OMMT nanocomposite were prepared by melt blending process in different ratios of components. The results showed enhanced properties of nanocomposites. The morphology of the PVC/ OMMT nanocomposites were studied by scanning electron microscopy (SEM), Infrared spectroscopy, X-ray diffraction (XRD) and thermal gravimetrey (TGA) analysis.

Keywords: Montmorillonite; Poly (vinyl chloride)-nanocomposites, thermal properties, organo Clay

1. Introduction

Poly vinyl chloride (PVC) has been studied for many years as an important polymer. Because of its little thermal stability and brittleness, PVC and its composites are subject to some limitations in some usages (Chaoying, et al., 2003). Now days studies are focused on the synthesis of PVC based layered silicate nanocomposites for developing the mechanical, physical and thermal properties (Yalcin, Cakmak, 2004).Currently, the most of researches were interested for the using of layered smectite clays as the reinforcing phase nanocomposite systems, because they have potentially high aspect ratio and show good properties. Also they are eco friendly and natural (Liu et al., 1999; Gilman et al., 1999; Mansoori et al., 2010). Several methods can be used for the modifying of MMT to make it organophile, such as using a quaternary ammonium and phosphonium salts (Gopalpur, 2011). Recently, the preparation and characterization of PVC/MMT nanocomposites formed by both melt and solution blending were reported (Wang et al., 2006). The flame retardancy, dimensional stability, gas permeability barrier properties have been reported (Theng, 1974). In this project for enhancing the morphological and thermal properties of PVC, we used OMMT as developing agent for this purpose by melt blending method.

2. Exprimental

2.1. Materials

PVC(DP=800) was produced by Abadan petrochemical Co, Iran. Sodium montmorillonite (Na^+-MMT) were purchaced from Fluka. And CTAB from Merk. All the reagents we used as received.

2.2. Synthesis of Organo Clay

For this purpose 20 gr of MMT was dissolved in 500 ml of distilled water and were mixed for two hours at 80 $^{\circ}$C to yield a homogeneous suspension. Then 9.20 gr CTAB were dissolved in 500 ml distilled water and then added to the MMT suspension and mixed for 24 hours at room temperature. Then was filtered and the residue were washed with distilled water. And the solids were dried at the oven in 70 °C for two hours. The synthesised orgono clay was then characterized by XRD and FT-IR.

Preparation of PVC/OMMT Nanocomposites PVC Resin, and Know content of OMMT were melt blended using a internal mixer bra bender at 145°C and rotor speed of 60rpm for 30 sec, followed by cooling under a pressure of 25mpa to give 1mm plates.

2.3. X-ray Diffraction Analysis

X-ray diffraction analysis were done, using Philips Xpert 3600diffractometer with Cu K_α radiation (λ=0.154nm) and a scanning rate of 4º/min.

2.4. Scanning Electron Microscopy

Scanning electron microscope (SEM) images were taken by VEGA//TESCAN from Czech Republic.

2.5. Thermal Analysis

Thermal analysis (TGA) was recorded on a TGA thermal analysis system from Perkin- Elmer Co, at a heating rate of 20 °C/min and at nitrogen atmosphere. The temperature scanned from 25-500 ^{0}C.

2.6. Fourier Infrared Spectroscopy

Fourier infrared spectroscopy (FT-IR) spectrum was recorded on a Perkin Elmer spectrum 100 apparatus.

3. Results and Discussion

3.1. Fourier Infrared Spectroscopy Analysis (FT-IR)

The modified MMT by CTAB through ion exchange process is described in part 2-2. This effect on MMT is evaluated by FT-IR as can be seen in Fig. 1. The absorption bands at 3649 and 3428 cm^{-1} are related to O-H stretching vibration, the band at 1067 cm^{-1} is due to Si-O vibration. In addition, the OMMT shows some new bands in the FT-IR spectrum as shown in this figure. The strong absorption bands at2925 and 2852 cm^{-1} are related to–CH_2 stretching vibration. These results show that alkyl quaternary ammonium ions have reacted.

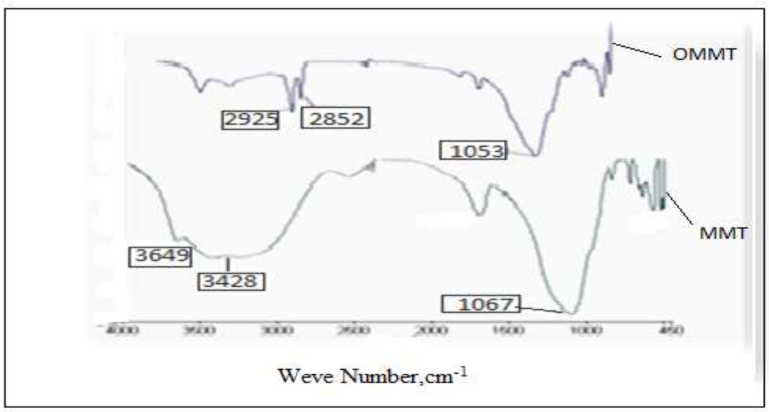

Fig. 1, FT-IR spectrum of MMT and OMMT.

3.2. Scanning Electron Microscopy Analysis

Scanning electron microscopy (SEM) images shown in Figures 2 and 3which are related to MMT and PVC/ OMMT surfaces, and shown some significant changes on the surfaces. In Fig 3. The formation of PVC nanocomposite of about 70 nm in diameter is determined, which is in accordance with the strategy of nano composite formation.

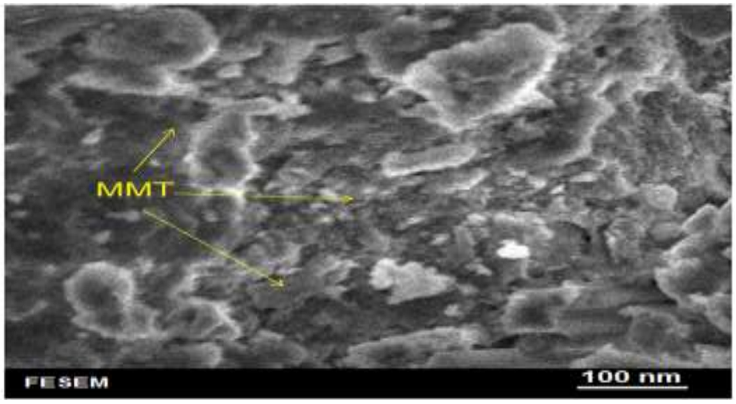

Fig. 2. SEM image of pure MMT

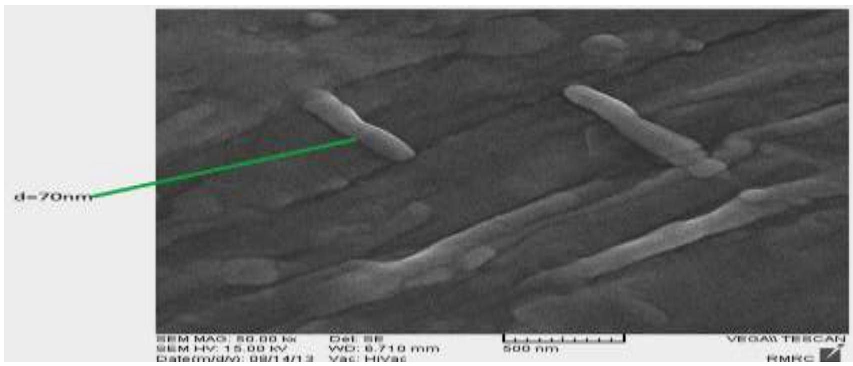

Fig. 3. SEM image of PVC/ OMMT

3. 3. Thermal Gravimetery Analysis (TGA)

Thermal gravimeter analysis is show in Fig. 4. The results showed that PVC/ OMMT nanocomposite exibit good thermal resistance than pure PVC in three weight percent. It can be found that PVC have been interlayered onto organophilic MMT layers and thermal stability were improved by increasing the OMMT ratio from 1 to 3 percent and decrease in 5 percent.

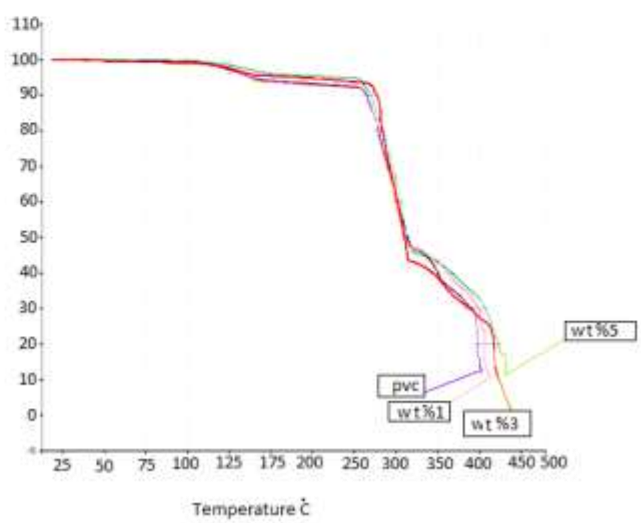

Fig. 4. TGA analysis of pure PVC and OMMT/ PVC at different weight percent (1, 3, 5).

3. 4. X-ray Diffraction (XRD)

In Fig. 5. The XRD pattern of pure MMT and PVC/ OMMT nanocomposite are shown. In MMT pattern shows that the (001) peak is located at around 8.3, related to a basal spacing of 1.2 nm. Also in PVC/ OMMT nanocomposites, the diffraction peak decreases in intensity and goes to lower angle with is related to f MMT. Also, by changing the MMT ratio from 1, 3 and 5 wt%, the interlayer of MMT were increases in comparison with pure MMT. This results show that PVC have intercalated into the layers of montmorilonite

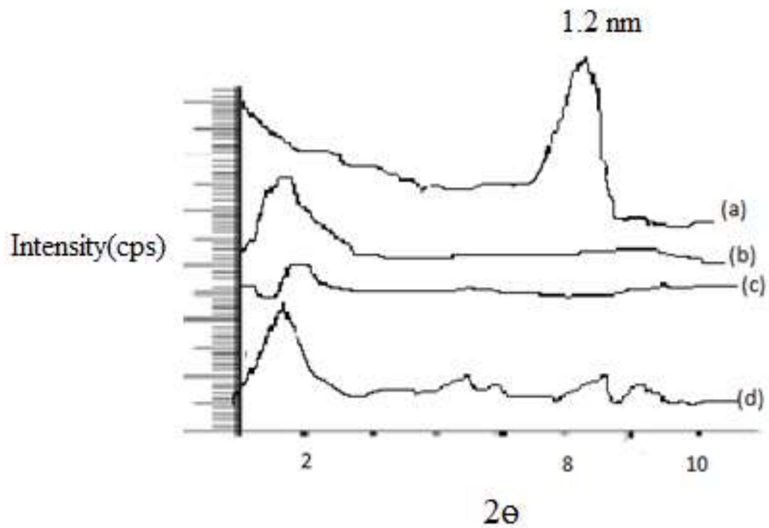

Fig. 5. X- ray of montmorilonite and PVC/ OMMT nanocomposites with various OMMT content: (a) pureMMT, (b) PVC/ OMMT (1 wt %), (c) PVC/ OMMT (3 wt %), (d) PVC/OMMT (5 wt %).

4. Conclusions

The effect of OMMT in the preparation of PVC/ OMMT nanocomposite is illustrated in this project for enhancing physical and thermal properties. FTIR and SEM images showed the formation of nanocomposite, and the influence of PVC onto the interlayers of OMMT.XRD patterns also approves the nanocomposite formation by melt blending process. TGA analysis also confirmed thermal stability of PVC/ OMMT nanocomposite than pure PVC. The result are in accordance with the nanocomposite formation and also SEM images shown the diameter about 70 nm of nanocomposite. This product can be used as an improved PVC in the industries.

References

Chaoying, wang. Xiuying, Qiao and Yong Zhang. Effect of different clay treatment on morphology and mechanical properties of PVC- clay nanocomposites, , Polymer Testing 22, 4, 453–46(2003).

Gilman JW. Morgan A, Giannelis EP, Wuthenow M, Manias E, flame Retardancy loth Annual BBC conference proceedings 1999,p. 1-11.

Gopalpur Nagendrappa, Applied Clay Science 53 (2011) 106–138

Liu, LM,Qizn, zhuXG. J.Appl. polym. Sci, Studies on nylon 6/clay nanocomposites by melt-intercalation process. 71,1133-8(1999).

Mansoori, Y. S.V. Atghia, M.R. Zamanloo, Gh. Imanzadeh , M. Sirousazar. Polymere – clay nanocomposites: Free-radical grafting of polyacrylamide onto organophilicmontmorillonite. European polymer Jornal 46,1844-1853(2010).

Theng BKG. The chemistry of clay organic reactions. New York: Wiley; 1974.

Wan, C.Y. X. Y.Qiao, Y. Zhang, Y. X. Zhang, Effect of epoxy resin on morphology and physical properties of PVC/organophilic montmorillonite nanocomposites, J. Appl. polym. Sci, 89, 2184(2003).
Wang Q, Zhang X, Jin Y, Gui H, Dong W, Lai J, et al.Preparation and properties of PVC ternary nanocomposites containing elastomeric nanoscale particles and exfoliated sodium montmorillonite. Macromol Mater Eng. 291:655–60(2006).
Yalcin, B. M. Cakmak. The role of plasticizer on the exfoliation and fracture behavior of clay particles in PVC matrix:a comprehensive morphological study. Polymer, 45, 6623-6638(2004).