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RESEARCH ARTICLE

MODIFICATION OF NANOCLAY FOR PREPARATION OF POLYVINYL CHLORIDE NANOCOMPOSITES AND EVALUATION OF THEIR MORPHOLOGICAL AND THERMAL PROPERTIES

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Abstract

Composite materials are solid multiphase materials formed through the combination of materials with different structural, physical and chemical properties. In thise study, 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 analysis (TGA).
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Keywords: Montmorillonite; Poly (vinyl chloride)-nanocomposites, thermal properties, organo Clay

Introduction

Poly vinyl chloride (PVC) has been studied for many years as an important polymer. Due to its inherent disadvantages, such as low thermal stability and brittleness, PVC and its composites are subject to some limitations in certain applications (Dictrich, 2001; Chaoying et al., 2003). Recently studies are focused on the synthesis of PVC based layered silicate nanocomposites for developing the mechanical, physical and thermal properties (Chaoying et al., 2003; Wang et al., 2001; 2002; Du et al., 2003; Trilica et al., 2001; Wan et al., 2003a,b). 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 exhibit great property enhancements. In addition, they are environmentally friendly and naturally occurring (Yalcin, and Cakmak, 2004; Liu et al., 1999; Gilman et al., 1999). Several methods can be used for the modifying of MMT to make it organophile, such as using a quaternary ammonium and phosphonium salts (Mansoori et al., 2010; Fan et al., 2003). Recently, the preparation and characterization of PVC/MMT nanocomposites formed by both melt and solution blending were reported (Wang et al., 2002). The flame retardancy (Du et al., 2003), dimensional stability, gas permeability barrier properties have been reported (Trilica et al., 2001). 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.

Experimental

Materials

Suspension polymerized PVC (PVC-WS-800, 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.

Synthesis of organo clay

For this purpose 20 gr of MMT was dispersed in 500 ml of distilled water and were mixed for two hours at 80 °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. The sheets were prepared for structure characterization and physical properties measurement.

Wide angle X-ray diffraction

Wide angle X-ray diffraction (WAXD) measurement was carried out using repXspilihPt 3600diffractometer with Cu K_{α}radiation) and(λ=0ascanning.154nmrateof4°/min. Bragg, s law, λ=2dsinθ,wasusedtocalculate the crystallographic spacing (d).

Scanning electron microscopy

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

Thermogravimetric analysis

Thermogravimetric analysis (TGA) was recorded on a TGA thermal analysis system from Perkin- Elmer Co, at a heating rate of 20 °C/min under a flowing nitrogen atmosphere. The temperature scan ranged from room temperature to 500 °C.

Fourier infrared spectroscopy

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

Results and Discussion

Fourier infrared spectroscopy analysis (FT-IR)

To enhance compatibility with polymers, the hydrophilic MMT is modified by CTAB through ion exchange process as described in part 2-2. This effect on MMT was investigated by FT-IR as shown in Fig. 1. The strong absorption bands at 3649 and 3428 cm^{-1} are due to O-H stretching vibration, the band at 1067 cm^{-1} belongs to Si-O deformation vibration. In contract, the OMMT exhibits several new bands in the FT-IR spectrum as shown in Fig. 1. The strong absorption bands at2925 and 2852 cm^{-1} are $–CH_2$ stretching vibration. These bands suggest that alkyl quaternary ammonium ions have tethered in between the silicate layers.

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.

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.

X-ray diffraction (XRD)

In Fig. 5. The XRD pattern of pure MMT and PVC/ OMMT nanocomposite are shown. The MMT pattern reveals that the (001) peak is located at around 8.3, corresponding to a basal spacing of 1.2 nm. For the PVC/ OMMT composites, the characteristic (001) diffraction peak decreases significantly in intensity and moves to lower angle with respect to those of Na+-MMT. Meanwhile, when the Na+-MMT loadings were 1, 3 and 5 wt%, the interlayer distances of MMT were enlarged by 1.9, 1.1and 2.0 nm, respectively, compared to that of pristine+-MMT. This suggests that PVC chains

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

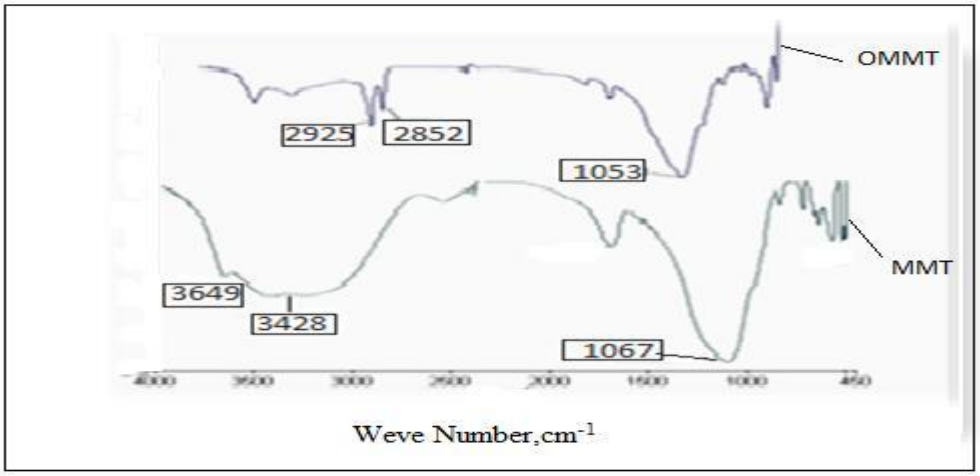


Fig. 2. SEM image of pure MMT

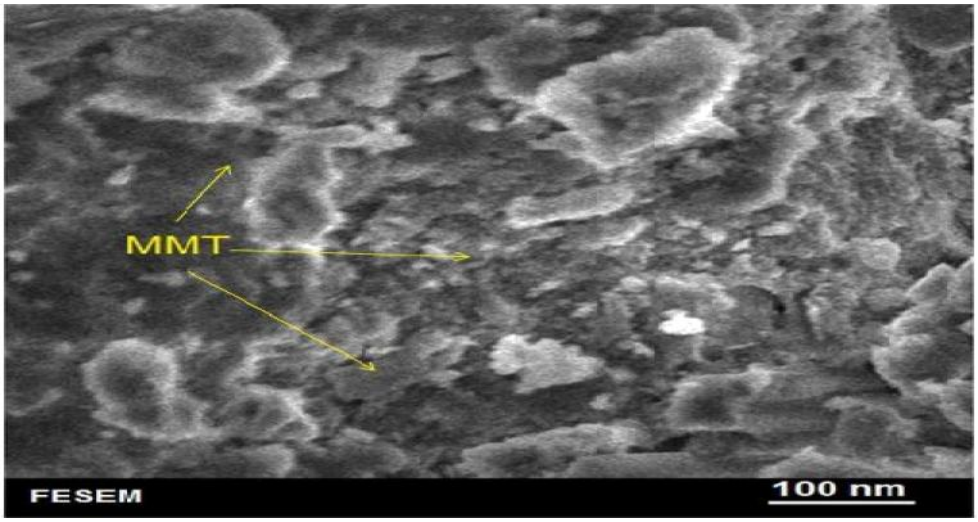


Fig. 3. SEM image of PVC/ OMMT

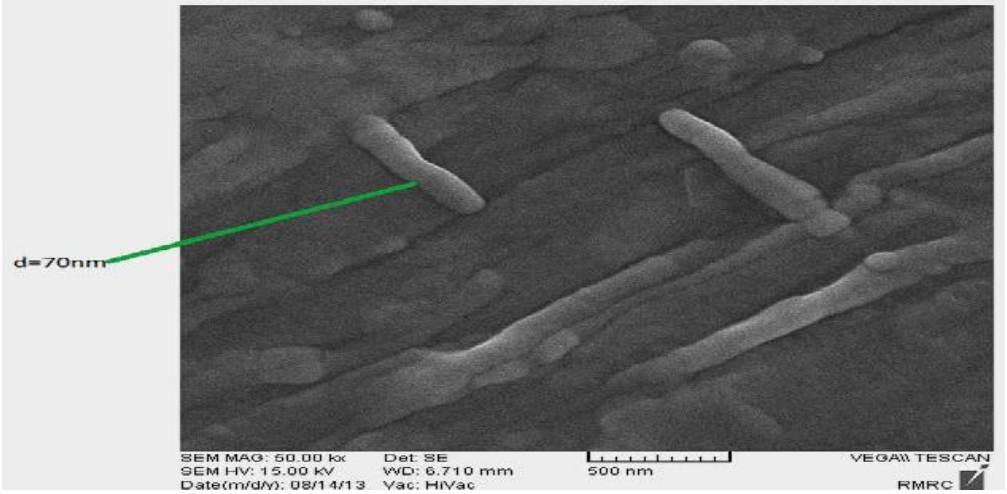


Fig. 4. TGA analysis of pure PVC and OMMT/ PVC at different weight percent (1, 3, 5).

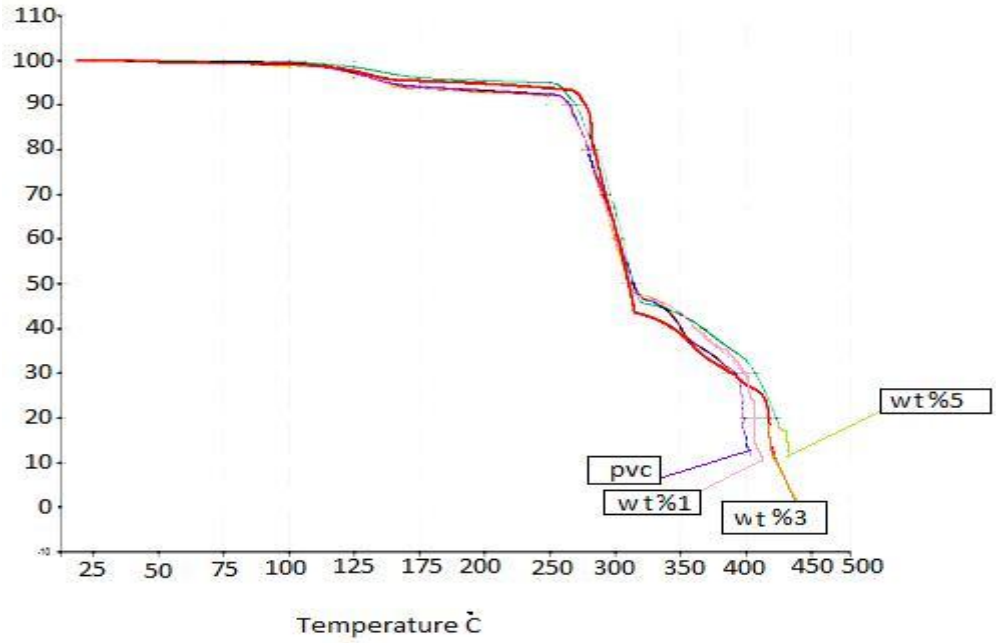
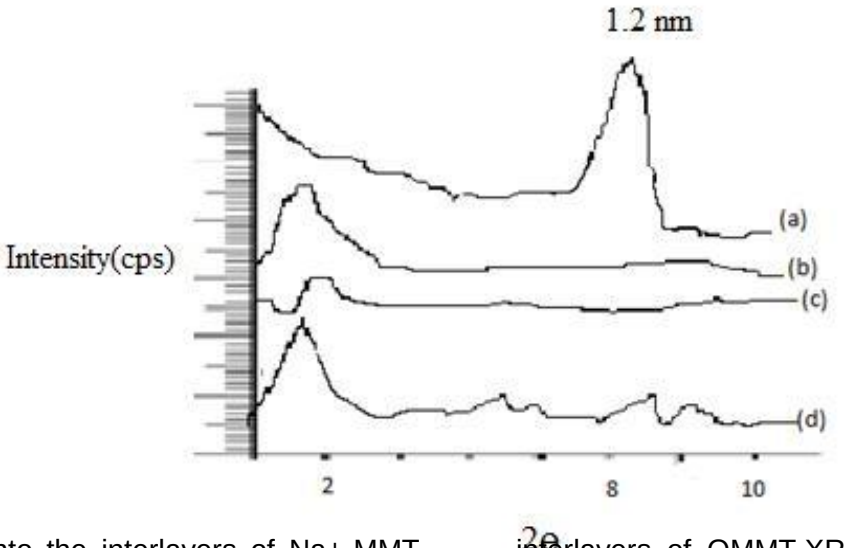


Fig. 5. X- ray diffraction patterns of MMT and PVC/ OMMT nanocomposites with various OMMT content: (a) MMT, (b) PVC/ OMMT (1 wt %), (c) PVC/ OMMT (3 wt %), (d) PVC/OMMT (5 wt %).



have intercalated into the interlayers of Na+-MMT and made some layers disperse in disorder.

Conclusion

The role 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.

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