Study the Optical Properties of PVA/Chitosan/MWCNT Films as Biodegradable Packaging with Different Ratios of Acetic Acid Concentrations and Film Thicknesses

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***Abstract*—Polyvinyl alcohol (PVA) films were synthesized in the presence of chitosan and multiwalled carbon nanotubes (MWCNTs) with different ratios of acetic acid concentrations and film thicknesses. In order to analyze the chemical bonds and the type of structure, prepared nanocomposites were investigated by Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction spectroscopy (XRD), respectively. By the way, ultraviolet visible spectroscopy (UV-Vis) was applied to survey the optical properties of nanocomposites.**

***Keywords*—Acetic Acid Concentration, Multiwalled Carbon Nanotubes, Optical Properties, Polyvinyl Alcohol**

I. Introduction

In the last decades, because of increasing concerns about nonbiodegradable productions, much attentions have been paid towards biodegradable materials [1-4]. Among these kind of materials, PVA is an excellent biocompatible and nontoxic polymeric compound [5]. In addition, due to existence of hydroxyl groups in own side chain, PVA has a good water solubility [5]. PVA has many applications in medicine, membrane production, food industries [6-8] and etc. Because of high degree of hydrophilicity of PVA, this chemical is very sensitive to moisture and such an issue is able to decrease the mechanical properties of PVA and then its applications in live environments. One of the most important factors in these types of films is their resistivity against passing the light through them. PVA films are transparent galore and almost all kinds of light can pass through them. It would be very interesting that researchers study the effect of some alternatives on the optical properties of the modified films. These alternatives can be nanotubes (CNTs), enhancing the film thickness, changing the pH level and so on. MWCNTs have been introduced as excellent fillers in producing nanocomposites.

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II. Experimental

In order to synthesize PVA/Chitosan/MWCNT nanocomposite, 0.9g chitosan was poured into aqueous solution acetic acid in different concentrations 1, 2, 5, 10 and 20% and the solution got shaken on a magnetic stirrer for 24 hours in room temperature. Then 0.025g MWCNT with 20 to 40nm diameter was added to chitosan solution and the material was sonicated in 25^{o}C for 30minutes. After that, a 10% PVA solution was prepared via solving PVA into ionized water in 95^{o}C and then the solution was added to chitosan solution after being fined. 0.3mL glycerol was added to the solution ultrasonicated for 4 hours till a homogenous solution was obtained. Finally the solution was poured into 5 equal petriplates in different magnitudes till different thicknesses of films were synthesized. The films were subject to room atmosphere for 48 hours and put into oven in 70^{o} C for 6 hours.

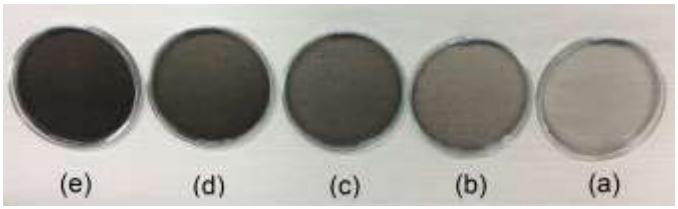

Fig. 1. PVA/Chitosan/MWCNT films with aqueous solution of acetic acid (1 wt%) in different thicknesses thicknesses

III. Discussion

Infrared spectra of the PVA/Chitosan/MWCNT films were measured for the film with 1% concentration of acetic acid as shown in fig. 2. The absorption peaks at 2939, 1440, 1333, 1092 and 850 (cm^{-1}) show the oscillations related to CH_2, CH-OH, CH, C-O and C-C. The observed peak in 1643cm^{-1} shows the stretching oscillation C=O.

Fig. 3. Shows the X-ray diffraction pattern for PVA/Chitosan/MWCNT composite film with the 1% concentration of acetic acid. A peak in the angle $2\theta=26^{o}$ is related to MWCNTs, two peaks around the angles 20 and 30^{o} are interpreted as the signs of PVA and also two broad peaks in 9.5 and 19.5^{o} show the presence of chitosan.

UV-Vis spectra of PVA/Chitosan/MWCNT nanocomposite films with different concentrations of acetic acid solution have been shown in fig. 4.

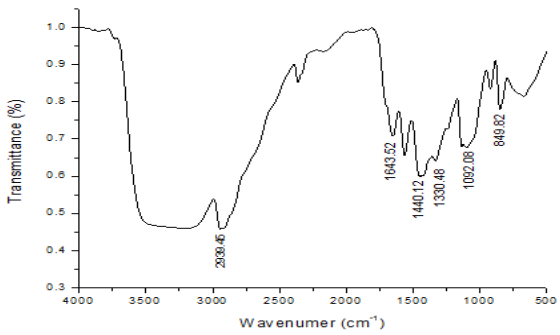

Fig. 2. The FTIR spectra of film of PVA/Chitosan/MWCNTs with the 1% concentration of acetic acid

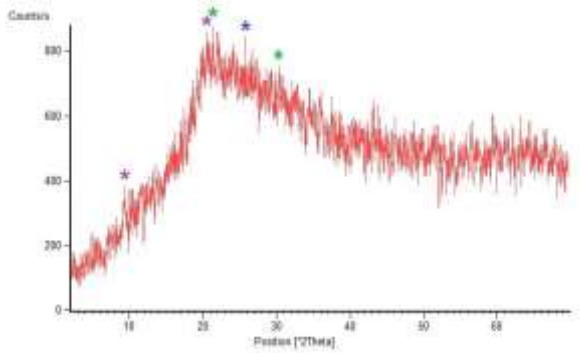

Fig. 3. XRD pattern for PVA/Chitosan/MWCNT film with 1% acetic acid concentration

It has been inferred that the more acetic acid in the solution, the less transmitted light both in the ultraviolet (200-400nm) and visual (400-800) regions.

UV-Vis spectra of the films with the concentration of 20% of acetic acid in different thicknesses have been shown in fig. 5. In order to do more accurate investigation and comprise the effect of enhancing the concentration of acetic acid and also the effect of increasing the thickness of the films on the transmittance of different light regions, the wavelengths 240, 300, 360 and 600nm were respectively selected as indices of the wavelengths of UV-C, 200-280nm, UV-B, 280-320nm, UV-A, 320-400nm, and visible light, 400-800nm, regions. It was seen that as the thickness of films are elevated, the light transmission decreases dramatically which is comfortable with the films' color change.

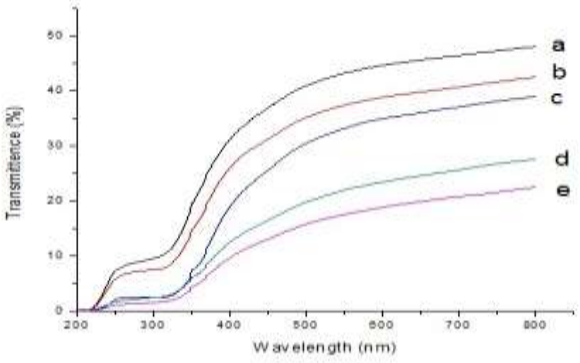

Fig. 4. UV-Vis spectra of PVA/Chitosan/MWCNT films with different concentration of acetic acid solutions a) 1% b) 2% c) 5% d) 10% e) 20%

It is noteworthy to mention that in the whole samples with different acid concentrations and different thicknesses, light intensity is stronger in the visual region than the UV region and this causes these films to have applications in food packaging industries thanks to their reminded transparency. In the first step, CNTs are the major reason which prevents the UV light from passing the films because of their intense absorption or scattering, but later the increase in acetic acid concentration and also the films' thicknesses amplify the absorption of light.

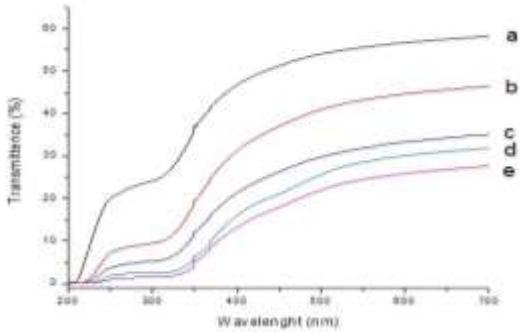

Fig. 5. UV-Vis spectra of PVA/Chitosan/MWCNT films with the concentrations of 20% of acetic acid in different thicknesses a) 0.03 b) 0.05 c) 0.06 d) 0.09 e) 0.11mm

IV. CONCLUSION

PVA/Chitosan/MWCNT films were synthesized in a polymeric matrix by the solution casting method [9] with the aim of manipulating the concentration of acetic acid solution and also the films' thicknesses. The effect of different ratios of the acetic acid concentration and also different thicknesses on the optical properties of prepared films were confirmed. In the all samples, passing of light has been deceased with the enhance of film thickness and acetic acid concentration. It opens promising aperture towards the broad use of PVA/Chitosan/MWCNT nanocomposite films in food industries in order to maintain the foods longer.

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