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Structural Investigation of Polyvinyl Alcohol/Polymethyl Methacrylate Blend

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Abstract: The present investigation is about the synthesis and structural characterization of polyvinyl alcohol (PVA)/ Polymethyl methacrylate (PMMA) blend. PVA and PMMA were mixed in proportion*i.e.*70:30, and the final sample in the form of ~ 40 μm filmwere peeled out from the dried dip-coated glass slide.Prepared films were characterized using Fourier Transform Infrared (FTIR) and UV-visible spectroscopies. Formation of new bands were observed in the FTIR spectrum of PVA, which confirms presence of guest polymer in the prepared blend. UV-visible analysis indicated the change in optical band gap with incorporation of PMMA in PVA/PMMA blend.

Keywords: Polyvinyl alcohol; Polymethyl methacrylate; Fourier Transform Infrared spectroscopy; UV-visible spectroscopy; Structural behavior

1. Introduction

Polymer is a macromolecule which is commercially very important. At present one can't think about life without polymers as all substances, which we are using in our daily life are somewhere made up of polymer [1-3]. So, interest is developed in scientific community from last few decades to synthesize new polymers or to tailor the characteristics of existing ones [4-8]. As one polymer can't have all the required characteristics, so blending of polymers of different types can be an effective technique todevelop a new material with required properties [9-11].

Polyvinyl alcohol (PVA) is a water soluble, oil resistant, has incredible emulsifying and cement properties, nontoxic, flexible and importantly it is a biodegradable polymer. It finds application in paper and textile industries and due to its non-toxicity and biocompatibility, it

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Vol-22-Issue-16-August-2019

has many medical applications, such as in eye-drops, contact lenses, cartilage replacement and other orthopedic applications but due to its hydrophilic nature it has limited strength, therefore it cannot withstand high temperature applications [12-15]. On the other hand, polymethyl methacrylate (PMMA) is used in automobile windows, cell phone screens, vivariums, optoelectronics, high-dielectric constant capacitors and electromagnetic applications due to its high weather resistance, excellent light transmitter, UV-stability and dimensional stability, but at the same timepoor impact, abrasion resistance, and volatility to organic solventsare its major drawbacks [16-18].

In the present work, an attempt has been made to incorporate the benefits and eradicate the disadvantages of both above mentioned polymers by developing a PVA/PMMA blend and to characterize its structural behavior.

2. Experimental details:

PVA and PMMA resin in the form of solid crystal and N-Methyl-2-pyrrolidone (NMP) with 99.9% purity were purchased from Central Drug House (CDH) Pvt. Ltd., India. PVA/PMMA blend was prepared by mixing 80:20 weight percentages of PVA and PMMA respectively, in NMP using magnetic stirring for 8 hrs. Glass slides were dipped in the prepared solutions and dried in the oven at 60 ^{0}C overnight. Finally, films (~ 40 μm) of prepared polymeric blendwith different compositions werepeeled off from the dried slides.FTIR spectra were recorded in transmittance mode using Shimadzu FTIR-8400S in the range 400-4000 cm^{-1}. Absorption spectra in ultra-violet and visible range were obtained from Shimadzu UV-2600.

ISSN: 0971-1260
Vol-22-Issue-16-August-2019

3. Results and discussion:

3.1 FTIR analysis

Fourier transform infrared spectra of untreated polyvinyl alcohol and polymethyl methacrylate are shown in Fig. 1. In FTIR spectrum of untreated PVA, absorption bands at 850 and 1451 cm^{-1}were assigned tostretching and bending mode ofCH_2bonds, respectively.Absorption bands of (C-O)-C-OH and CO groups were visible at 1095 and 1143 cm^{-1}, respectively. Deformation modes of (CH)-CH_2groupswere observed at 1510$cm^{-1,}$ CH stretching vibrations were revealed around 2930 cm^{-1}, and broad absorption band between 3100-2600 $cm^{-1}$was indicating the presence of OH groups [20].In Fig. 1 characteristics absorption bands of polymethyl methacrylate are shown with red color. Symmetric and asymmetric stretching vibrations of C-O-C bonds were seen at 1145 and 1238 cm^{-1}, respectively.Skeletal stretching of polymer backbone was assigned to the absorption band at 1053 cm^{-1}, -C=O groups at 1732 cm^{-1}, twisting or wagging vibrations of CH_2at 1386 cm^{-1}, bending vibration of CH_2at1449cm^{-1}, stretching mode at 2845 and 2950 cm^{-1} and C-H stretching vibrations were observed at 2990 cm^{-1} [20].

In Fig.1, Fourier transform infrared spectra of PVA/PMMA blend is presented with blue color. Noticeable changes in the FTIR spectrum of PVA were observed whenPMMA was incorporated in the blend. After theincorporation of 30% PMMA by weight in the PVA/PMMA blend, characteristics bands such as at 988, 1192, 1238 and 1732 $cm^{-1}$of PMMA were clearly visible in the FTIR spectra, consequently, it is expected that the resultant blend may have better strength and durability than untreated PVA. Intensity of prominent bands of PVAsuch as at 850, 1095, 1145, the absorption 2900-2940 and between 3100and 3600 cm^{-1}wassustained, which revealed the retainability of original structure of PVA and consequently it's biodegradability, in the prepared polymeric blend.

3.1 UV-visible analysis

ISSN: 0971-1260
Vol-22-Issue-16-August-2019

UV-visible absorption spectra of PVA, PMMA and PVA/PMMA (80:20) blend are shown in Fig.3. It is observed that the absorption edges of untreated PVA and PMMA were found at 255 and 265 nm, respectively, which were attributed to their respective optical band gaps. Further it is noticeable from the same figure that the absorption behavior of the prepared PVA/PMMA blend with composition70:30 was lying between PVA and PMMA, indicating the decrease of band gap of PVA after the incorporation of PMMA.

Conclusions

On the basis of the above-mentioned results and discussion it can be concluded that the prepared PVA/PMMA polymeric blend is exhibiting the behavior of both host and guest polymers so possibly it may have better optical property, dimensional stability, and more durable, without much compromising its biodegradability.

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Vol-22-Issue-16-August-2019

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ISSN: 0971-1260
Vol-22-Issue-16-August-2019

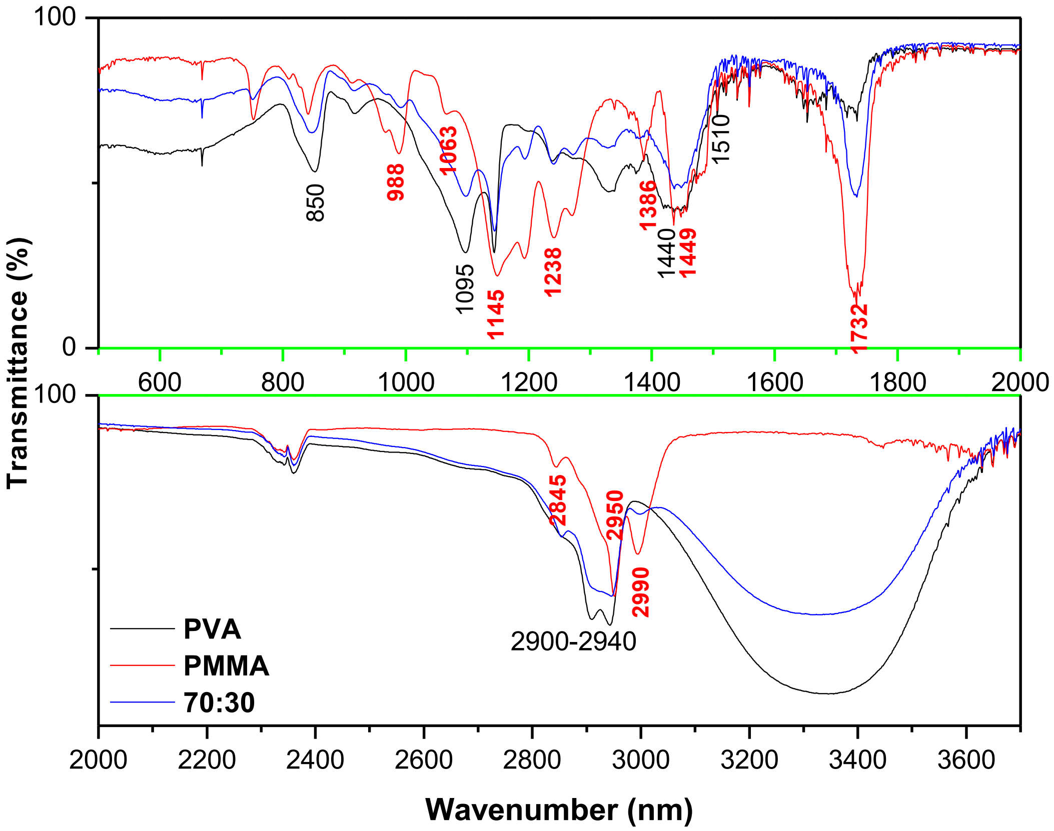

Fig. 1 Fourier transform infrared spectra of PVA, PMMA and PVA/PMMA blend.

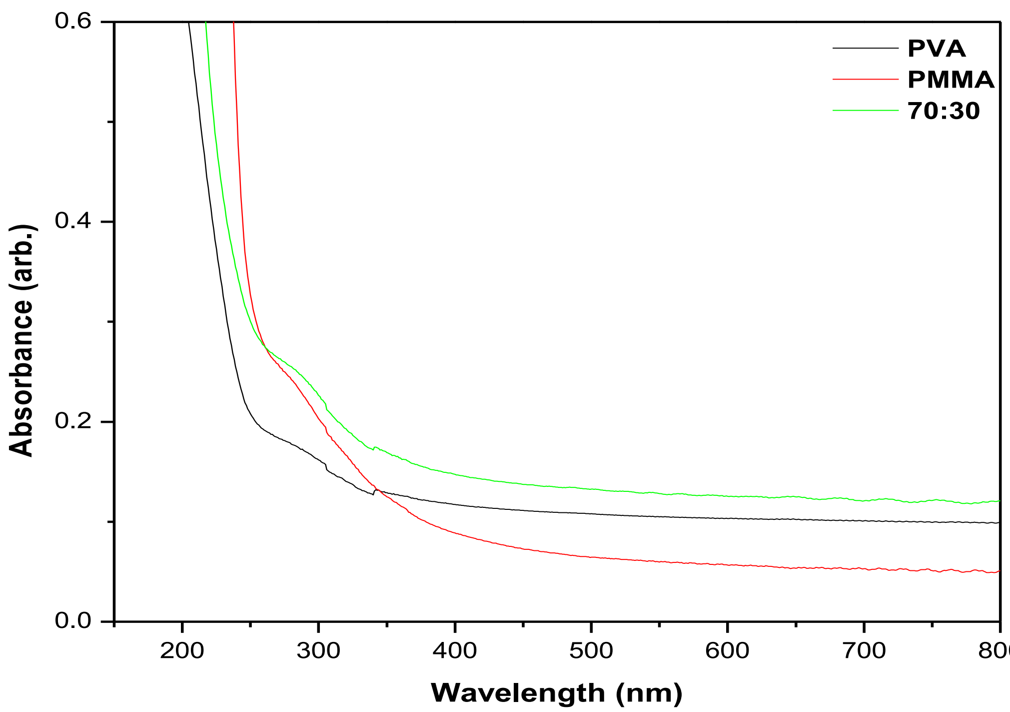

Fig. 2 UV-visible absorption spectra of PVA, PMMA and PVA/PMMA blend.