Spin Coated Polymer films: Their Structural and Optical Properties

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Abstract: We report on the structural and Optical Properties of Polymeric films. The thin films of different compositions of polymer blends were prepared by using Spin Coating Technique. X-ray diffraction patterns for the spin coated PVP/PPO polymer composite films. The present study aims to introduce the reader with polymer characterization techniques. The absorption edges of pure polymer films are found at 226.9nm and 255.7nm and it is found to red shift upon blending (PVP/PPO). Pure polymers show one absorption peak each while polymer blend films show two different absorption peaks below the absorption edge, it may due to the electron transitions between the different functional groups of the polymers. The blending of polymers continues to be a major area of polymer research in academia and industry.

Key words: Polymer Blends, Spin Coating, XRD, UV-Vis spectroscopy

Synthesis of polymeric films

A polymer blend is a member of class of materials analogus to metal alloy in which two or more polymers are blended together to create a new material with different physical properties. Preparation of individual ratio of blended polymer requires many combinations and each has to be individually characterized. The PVP films were prepared from a spectroscopic grade compound (Mw 40 000 g/mol and polymerization mumber m) 360) from Aldrich chemicals. Pure polymer solution of PVP and PPO were prepared by dissolving the respective polymers in chloroform. Firstly, 0.5 g of PVP stirred in 20ml chloroform for 3 hours. Other samples were prepared by doping 10%, 20%, 30% and 50% by weight of PPO polymer in PVP polymer and continuously stirred the solution for 3 hours.The thin films of different compositions of polymer blends were prepared by using Spin Coating Technique. After doing this procedure, films are required for UV, XRD and FTIR studies.

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Characterization Technique

Powder diffraction (XRD) is a technique used to characterize the crystallographic structure, crystallite size (grain size) and preferred orientation in polycrystalline or powdered solid samples. Optical transmission studies were carried out to estimate the band gap and absorption edge of the films by using UV-visible spectrophotometer (SHIMAZU CORPORATION, JAPAN) in wavelength range from (200-1100nm)

FTIR spectroscopy

FT-IR stands for Fourier Transform Infrared, the preferred method of Infrared Spectroscopy. In this method, IR radiation is passed through a sample. Some of the infrared radiation is absorbed by the sample and some of it is transmitted.The resulting spectrum represents the molecular absorption and transmission,creating a molecular fingerprint of the sample. FTIR can provide the following information:

i) It can identify unknown materials
ii) It can determine the quality or consistency of the sample

iii) It can determine the amount of components in a mixture.

Results and Discussion

XRD studies

Figure 1 shows the X-ray diffraction patterns for the spin coated PVP/PPO, polymer composite films. The broad diffraction band has been observed showing their amorphous behaviour. The position of the broad peak intensity and/or the diffraction angle does not show any change with the change in the composition of these blends showing their miscible nature of both these polymers films.

Optical properties of PVP/PPO films

Optical studies of spun cast polymer blend films are carried out to estimate the band gaps of the thin films using uv-visible spectrophotometer in wavelength range from (200nm-1100nm). Pure and doped polymer thin films are subjected to UV visible absorption studies. The absorbance is plotted against the wavelength for pure and doped polymer films as shown in figure 2.

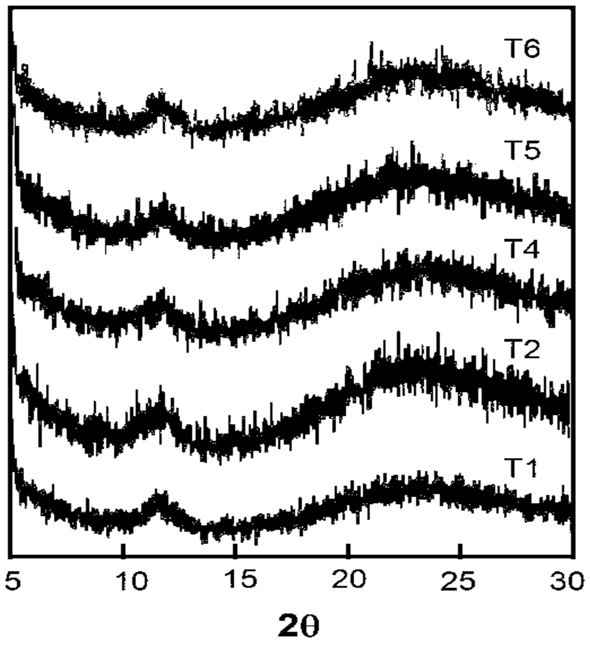

Figure 1: X-ray diffraction patterns for the PVP/PPO composites polymer films

The optical band of pure PVP and PPO polymer films are 5.23eV and 4.63eV whereas doped polymer films show reduction in band gap. The reduction in band gap may be due to the incorporation of PPO polymer into the PVP polymer and it may effect polymeric chain bonding. The UV visible absorption spectra of pure polymer thin films show only one absorption band while doped film show two absorption bands.

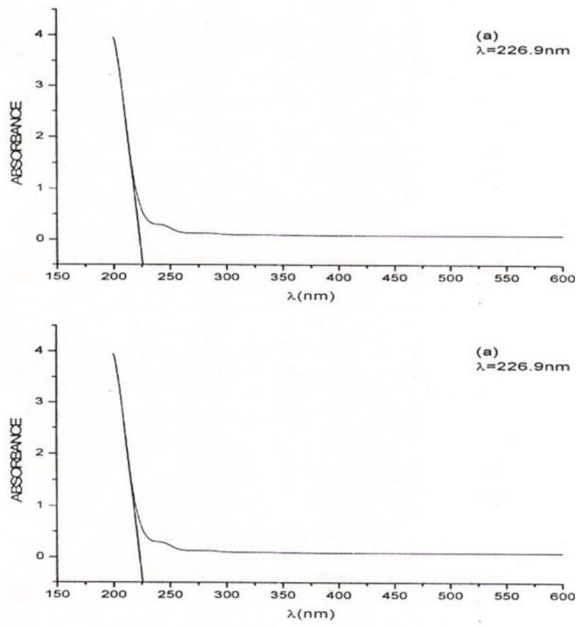

Figure 2(a) and 2(b) Absorption spectra of pure PVP and PPO polymer

FTIRStudies

FTIR spectroscopy is a technique to study to study the interaction between polymer-polymer blends. The prepared composite films were transparent. The FTIR transmittance spectra for pure and doped polymer films were recorded using FTIR spectrophotometer having wave number range from 400-4000cm-1PVP/PPO polymer blends spectra analysis: The FTIR spectra of PVP/PPO polymer blend containing following composition is shown in figure 3.

Conclusions

The important conclusions drawn from the present work are:

1. The absorption edges of pure polymer films are found at 226.9nm and 255.7nmand it is found to red shift upon blending (PVP/PPO).
2. Pure polymers show one absorption peak each while polymer blend films show two different absorption peaks below the absorption edge, it may due to the electron transitions between the different functional groups of the polymers.
3. The band gap value along with the indirect transition gap was calculated. The optical gap of pure PVP and PPO polymer films are 5.23eV and 4.63eV respectively. Polymer blends (PVP/PPO) of different show reduction in optical gap.
4. FTIR spectra of PVP polymer show absorption peak at 1290cm-1 which attribute to primary aromatic amine C-N stretching and for PPO polymer at 1190cm-1 attributed to C-O stretching.
5. Absorption band observe at 1190, 1189, 1187cm-1 indicate C-N and C-O stretching and these peaks indicate bonding in polymer blends.

Applications

1. The majority of polymers are thermoplastic, meaning that once the polymer is formed it can be heated and reformed over and over again. This property allows for easy processing and recycling.
2. Polymers can be very resistant to chemicals.Consider all the cleaning fluids in your home that are packaged in plastic
3. Polymers can be both thermal and electrical insulators. The thermal underwear that many skiers wear is made of polypropylene and the fiberfill in winter jackets is acrylic.
4. Polymers are very light in mass with varying degrees of strength.Consider the range of applications, from dime store toys to the frame structure of space stations, or from delicate nylon fiber in pantyhose to Kevlar, which is used in bulletproof vests.
5. Polymers can be processed in various ways to produce thin fibers or very intricate parts.Plastics can be molded into bottles or the body of a car or be mixed with solvents to become an adhesive or paint.
6. Most important polymer blends are used for fabrication of devices such as Solar Cells, LED's etc.

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