INVESTIGATIONS ON CHARACTERIZATION OF POLYSTYRENE AND POLYMETHYLE MYTHCRYLATE THIN FILMS

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Abstract : Thin film in the form of pure and blend types perform differently depending on their activation energies and other physical properties. The thin films such as Polystyrene (PS) and Polymethyle Mythcrylate (PMMA) are prepared by dip coating technique. Pure and blended forms of thin films are studied in the context of activation energy and Fourier Transform Infrared (FTIR) methods. The spectra of FTIR for PS and PMMA are studied. The spectra showed contrast character for pure and blended form of both for PS and PMMA. There are interesting peaks in thin films depending on its microstructure. In the present work, FTIR analysis has been applied for both PS and PMMA. The results obtained are presented in the background of FTIR method. A few illustrations for PS and PMMA are also discussed in the present work.

Keywords : Characterization, Coating technique, Fourier Transform Infrared (FTIR) methods, Polystyrene (PS) and Polymethyle Mythcrylate (PMMA), Thin films.

Introduction: Thin film is considered as a layer of solid, liquid or gas matter. They have been found to be large surface to volume ratios. Consequently surfaces largely define the characteristics of thin films. Therefore they initially applied in protective coatings, polymer applications, and microelectronics besides IC technology. With this also the interest of investigators, scientists and researchers increased interest for further explorations and understanding physics behind these usages. Polymer thin films are generally composed of long molecular chains [1] made up of relatively simple molecules. The production of organic polymer layers on surfaces has received much more attention than the formation of inorganic polymer films [2]. The optical and electrical properties of polymers were highlighted by the researchers such as Lamie shahad etal [3]. There is further scope for finding the microstructure and thin film response for the blended thin films. The pure forms of thin films PMMA and PS have been known for optical, electrical conduction properties. It is interesting to understand the physics behind the blended categories of thin films PS and PMMA. In this direction, attempts are made to study the blended PS and PMMA as well as pure type. The present work employs Fourier Transform Infrared (FTIR) to study PMMA and PS, pure and blended and the results obtained are presented in the following text.

Outline of FTIR method: Infrared spectroscopy is one the most important analytical techniques from which it is relatively easy to obtain the spectra of solids, liquids, gases and polymer films. The sample preparation is carefully carried out for the chosen types of thin films. In this method the sample is mixed with a suitable dry alkali halide, ground in a mortar or ball mill and subjected to a pressure of about 10 ton/sq in an evacuated die. This sinters the mixture and produces a clear transparent disc. It is essential that the crystal size be reduced to about 2.5 μm. the most commonly used alkali halide is Potassium Bromide (KBr), which is completely transparent in the commonly scanned region. The spectrum quality can often be improved by stirring the KBr in an oven at a temperature above the ambient and also by heating the resultant disc in a vacuum oven before recording the spectrum; both these measures reduce moisture content. In the present work Bruker IFS – 66V FT – IR

Instrument was used to study the structure of pure and blended PS and PMMA. The sample chosen for the studies are 1) PS-pure, 2) PMMA-pure and 3) PS/PMMA blended. For blended thin film samples a ratio of 250:750 is used. Other blends can also be prepared in the same manner.

Results and analysis: After application of FTIR to the samples under the subject, several interesting findings are revealed. The results obtained, pure and blend for PS and PMMA are presented below, [4] both PS and PMMA showed in fig 3.4, 3.5 and 3.6. These results show nature of bonding and different functional group present in the thin film. From the spectral studies, the peaks analysis revealed the vibrational bonds at different wave numbers. The assignments based on bond type have been furnished in the table-1. The type of assignments also confirms to the results achieved by the researchers [5]. The vibrational bond assignment is shown in Table-1 [5]

Table - 1

FT – IR Vibrational bands of PMMA, PS and PMMA blend.

Wave number (cm^{-1})			Band assignment
PMMA	PS	PS - PMMA	
---	694	694	C – C bending (Ring Puckering)
698	---	---	C – C bending (Wagging)
---	752	752	C – H bending
1240	---	1238	C-O-C asymmetric stretching
1732	---	1728	C=O stretching

Fig 1 shows characteristic spectra showing variation of intensity transmittance with wavelength of incident light. The transmittance T with wavelength increases. For PS it is 17%; PMMA it is 25%, where as blend shows different picture/trend. It is nearly 70% for PMMA 25 sample. Also it may be noted that transmittance also dependent on concentration of mixture ingredients in thin film sample. This also in line with finding of investigators [6]

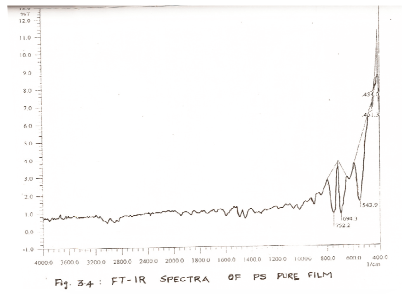

Fig.1 FTIR spectra of PS pure film

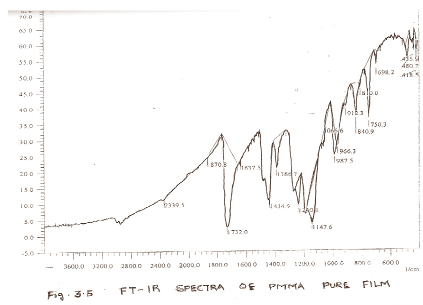

Fig.2. FTIR spectra PMMA pure film

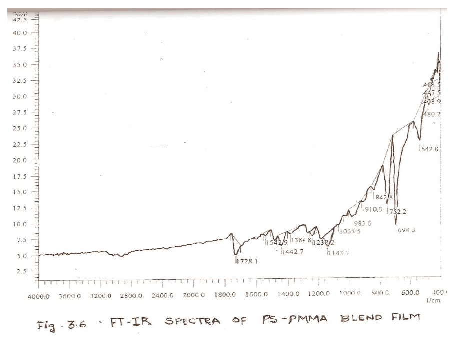

Fig.3. FTIR spectra of PS-PMMA blend film.

Percentage of transmittance with wave number shown is shown in Fig 1. Troughs (lower peaks) found at 543.9, 694.3, and 752.2 as can be seen from the fig these are characteristic lower peaks (trough) for pure PS

On comparing the spectra of pure and blend polymer complexes the following conclusions have been arrived.

The Corbonil stretching vibrational band C = O observed at 1732 cm^{-1} for pure PMMA is shifted towards lower wave number side in the PMMA – PS blend composition.

The C – C bonding vibrational band observed at 698 cm^{-1} for pure PMMA is disappeared and band is appeared at 694 cm^{-1} with increased intensity in the blend polymer complexes. This effect is due to the blending of polystyrene in which the intense C – C bending (for ring puckering) is observed at 694 $cm^{-1.}$

Results and Interpretations: The higher activation energies are found in blended thin film samples. So also C=O bond was observed at wave number of 1728cm^{-1}. These results indicate the strong bonding in blend of PS and PMMA samples with higher activation energies of molecules. Also as can be seen from the results that the bond response characters are different for PS (694,752 cm^{-1}) while for PMMA (698,750 cm^{-1}) are different. The strong bond structure is found 1700 cm^{-1} both for PMMA and blend as PMMA dominates the bond nature of mixture of blend sample of thin films. Hence FTIR is found quite useful in assessing the microstructure of thin films of PS, PMMA and blended.

Conclusion : On the basis of investigations the following interesting points are obtained.

The structure of pure and blend forms have structure of amorphous solid nature. FTIR technique is powerful tool in finding bonding vibration modes of solid in particular thin films. This can be used to obtain spectra of thin films to find bonding, blending and vibrational status of microstructure.

The method FTIR confirms the blending of PS and PMMA materials as obtained in the positions of peaks in specific type of thin film.

The spectral characteristics of pure form of PS, PMMA and blended form revealed that:

1. The spectrum is unique for each type of thin film whether it is PS, PMMA or blended.
2. More number of peaks is observed in FTIR spectra of PMMA compared to PS
3. In the blend thin film, only one prominent peak at671cm^{-1} is observed.
4. FTIR is a useful tool to study microstructure of thin films.

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