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Assessment of Thin Film by Alternative Approach of FTIR Technique

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Abstract—*The rapid growth of material science in the last few decades has seen tremendous growth and new type of challenges in polymers, especially in the category of thin films. With development of new kinds of thin films in offing in ever today, it has become essential to find a new method or technique to assess the purity of polymer thin films. In this connection the present studies are undertaken to understand and characterize polymer thin films. In the present work a few of thin films such as Polysterene (PS), Poly methyl methcrylate (PMMA) and Mixtures of thin films are studied in their pure form as well as in the form of mixture using FTIR technique. The results of these studies on these thin films have shown some important aspects to charecterize and determine the purity level of thin films. The spectra of FTIR are unique and distinct for particular type of thin films. The spectral studies of thin films and blend forms of thin films are presented and discussed in these research investigations.*

Key words*: Thin films, Polymers, Polysterene (PS), Poly methyl methcrylate (PMMA), Mixtures, Optical characteristics, Fourier transform Infrared spectroscopy (FTIR) technique, Purity level of thin films.*

1. INTRODUCTION

The rapid growth of material science in the last few decades has seen tremendous growth and new type of challenges in polymers. Although techniques of analytical nature such as XRD, optical properties, physical and electrical properties are widely employed to gain insight into physics of thin films, these will only provide partial nature about solid thin films.

For instance, X–Ray Diffractometer (XRD) analysis conducted with Nickel filtered (CuKα) radiation will provide structures of polymer thin films. The spectra will provide intensity of radiation with Bragg angle. The vibrational molecular aspects are not revealed in these spectra of polymer thin films. Whereas in the case of AC Conductivity will give information about conduction in thin films, which means the effect of conductivity under applied electric field [5,6,7]. The positions of bonding vibrational aspects are not conveyed in this study. In respect of optical properties by double beam spectrometer, the ratio of radiant power of two electromagnetic beams over predetermined wavelength is measured. The normal transmittance spectra of polymer films with respect to wavelength region are obtained. The transmittance co efficient, absorption coefficient in relation to wavelength gives the optical nature of polymer thin films [4]. From these points it is clear that, there is essential need of analytical tool to fill up the gap which will throw light on the micro aspects of polymer thin films such as type of bond intensity, bond strength, vibrational aspects and others. These requirements are attempted to be solved using application of FTIR technique [3].

In this study FTIR technique is employed as analytical method to understand micro structural nature of polymer thin films.

2. EXPERIMENTAL WORK

FTIR is important technique to obtain a typical spectrum for any kind of matter whether solid, liquid or gas including thin films. For experimental studies two kind of thin films are employed namely, Polysterene (PS) and Poly methyl methcrylate (PMMA) and also mixture of either of them to obtain hybrid films [1, 2]. These hybrid films will provide entirely new understanding and new type of Fourier transform Infrared spectroscopy (FTIR) spectra.

The outline of experiment is simple. In this sample is mixed with suitable dry alkali halide grounded in a mortar or any other suitable device such as ball mill and the sample is subjected to a pressure of 10 ton/inch^2 in a evacuated die. This sinters the mixture and produces a distinct transparent disc sample. It is adjusted such that, sample size is around 2.5 microns. Potassium bromide is alkali halide is employed because it is completely transparent for investigations. Care is also exercised by proper stirring of KBr in an oven at a slightly higher temperature above ambient. The disc sample is then subjected to vacuum drying and the sample can be used for experimental studies. In the present study Brooker IFS FTIR instrument was employed for investigations of polymer thin films. The samples for the experiments are Polysterene (PS) and Poly methyl methcrylate (PMMA) and their mixtures.

3. RESULTS AND DISCUSSIONS

The experiments conducted on thin films showed some interesting features. The aspects of thin films will characterise distinctly depending on type of thin film [8]. The results and highlights of the work are presented in this paragraph.

Diagrammatically results are condensed in Fig-1, Fig-2 and Fig-3

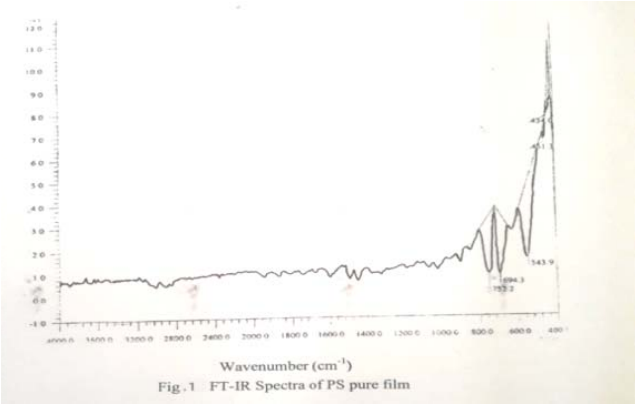

Fig .1 FT-IR Spectra of PS pure film

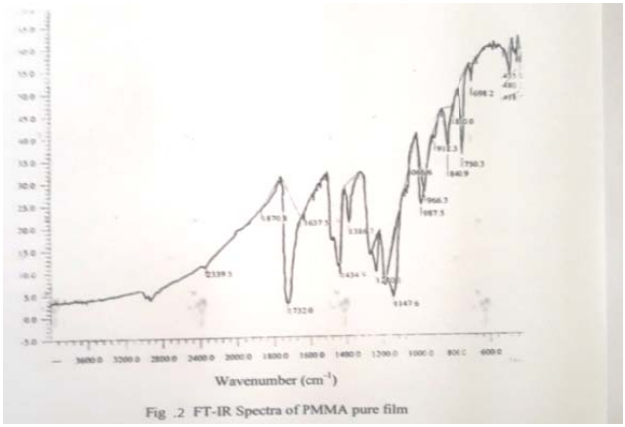

Fig .2 FT-IR Spectra of PMMA pure film

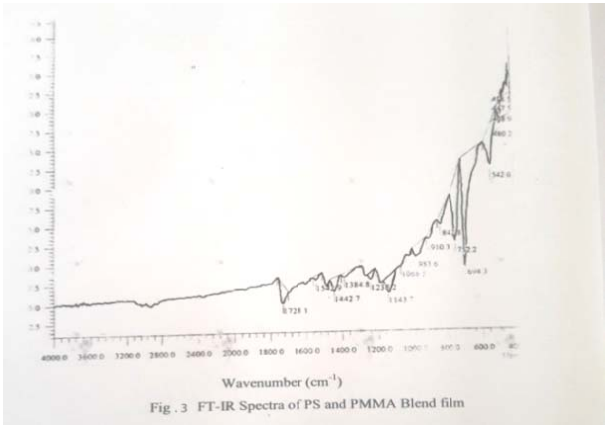

Fig .3 FT-IR Spectra of PS and PMMA Blend film

Fig-1 as shown above depicts FTIR spectra of PS polymer thin film.

The intensity of spectra is shown against wave number/cm. It can be seen that up to 800/cm there is base line without any prominent maxima or minima. Minima are found at 752/cm, 694/cm and 543/cm which characterise molecular bonds corresponding to bond assignment of C-C and C-H. This spectrum is unique for the kind of pure PS film by FTIR technique.

Fig-2 describes FTIR spectra of PMMA thin film. These spectra of intensity verses wave number/cm is entirely different compared to previous PS polymer thin film. The difference can be clearly noticed in the FTIR spectra of PMMA. The characteristics of spectra throws light on spectra of concising of many distinct minima's which are absent in the previous case of PS film. This is the characteristic of PMMA thin film and can be employed as a reference guide to identify thin film using FTIR technique. In this sense this method is potentially useful to assess, identify and characterise thin films. The spectra of PMMA thin film starts minima at 1732/cm and ends up at 435/cm containing very clear minima of the order of 6 to 7 numbers which vary depending on purity of thin film.

Fig-3 shows spectra of mixed thin film called hybrid PS and PMMA. This can also be called as blend variety of PS and PMMA thin film to find the nature and characteristics of thin film.

As can be seen from fig-1, fig-2 and fig-3 the spectra of blend thin films neither resembles that of PS thin film nor that of PMMA thin film. This gives a reference of spectra is not so pure as either PS or PMMA thin film because in the lower range of 1752/cm is not so clear and also number of minima's as presented by PMMA are also not so distinct. However very close examination of spectra will reveal striking features. The spectra in lower wave number/cm obscurely resembles PS in lower wave number and do not resemble in higher wave number/cm in case of a blend thin film spectra.

However at higher wave number the spectra of blend thin film is approximately close to that of PMMA characteristics. Thus the thin film can be characterised in lower numbers with the band assignment of C-C and C-H for pure PS thin film. For PMMA pure thin film higher wave numbers from 1200 onwards will reveal band assignment of C-O-C, CH_3, C=O, CH which characterise pure PMMA thin film. Therefore the above investigations and spectral studies have suggested unique features of pure thin films and mixed variety of thin films. Any slight change in purity of thin film will be reflected in FTIR spectra as can be seen from spectra of blended thin film. And this method can be used for assessing of purity assessment of solid thin films.

4. CONCLUSION

Based on studies of pure thin film and their mixtures, the below mentioned important inferences are drawn.

1) FTIR technique is a potential method and can be used to apply to determine purity and assessment of polymer thin films.

2) Any slight variation in the type of polymer thin film will be revealed in the nature of FTIR spectra of thin film.

3) The reference spectra for each type of thin polymer film can be data banked and can be employed as reference guide to characterise any thin film.

4) There is a vast scope for further studies in understanding FTIR spectra for polymer thin film using FTIR which is found to be versatile technique in characterising thin films.

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