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Evaluation Studies in Understanding Optical Characteristics of Thin Films

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Abstract: The thin films have good properties such as chemical stability, low dielectric losses and good dielectric strength besides other physical and electrical properties. The reports of literature indicate studies on polymeric materials for characterization of some properties such as frequency response, activation energy and electrical properties of thin films. The literature indicates seldom studies on hybrid / blend thin films. The blend thin films the nature and properties are of keen interest for researchers in the area of electrical conduction and dielectric properties. Interestingly it is of great interest to understand and evaluate optical characteristics of thin films. The optical characters of thin films are not investigated much. However it is of interest to understand optical behavior of thin films in view of their wide applications in electronic and electrical industry. Because of extensive usage to thin films mainly polysterene (PS) and Poly methyl methcrylate (PMMA) are chosen for the study. The optical characteristics, absorption and extinction co-efficient have been studied for pure as well as hybrid thin films of PS and PMMA. Refractive index is an important optical parameter is also studied in the wavelength range 500nm to 3000nm range. Optical nature of pure and hybrid thin film has been evaluated and discussed in the current paper.

Key words: Absorption, Optical characteristics Polysterene, Poly Methyle Mythcrylate, Thin films, Transmittance.

INTRODUCTION

The pivotal role of thin film technology in the development of microelectronics, optical coatings and integrated optics, quantum engineering, metallurgical coatings, surface engineering and solar energy conversion devices is well known. The availability of ultra high vacuum techniques has brought significant developments in their film deposition techniques from the rather sample thermal evaporation to more sophisticated and expensive molecular beam epitaxy.

The properties of polymers are depending upon molecular configuration, the degree of polymerization, branching and cross linking. Further the properties are also depending upon the mode of production. Thin films of polymeric material are finding increasing importance as encapsulants and dielectrics in the micro-electronics industry. They can also because as anti corrosion coatings because of their chemical inertness. The production of organic polymer layers on surfaces has received much more attention than the formation of inorganic polymer films [1].

The electrets microphone requires low voltage and its frequency response is superior to all other microphones. Due to its very good photosensitivity, it can be used for solar cell applications. Lamies Shahada et al [2] studied the optical and electrical properties of a polymer. The optical permittivity and the dc conductivity have been deduced, and the activation energy has been calculated and found to be 0.023 eV. A detailed study of optical absorption has been done. Eric Wolde et al [3] have done the optical analysis of dichroism measurements in polymer science. S.C.K. Misra et al [4] studied in detail the optical and electrical properties of BF_4- deposed polypyrole (PPY). The electrical conduction in solution grown poly Carbonate films was studied by Suresh Chand et al., at different voltages between 1 and 10^4 V as a function of temperature in the range 328 –420K at a constant thickness of about 50µm [5].

The survey of literature shows that though extensive work has been carried on the thin film of many polymeric materials, in view of their wide applications, further investigations are required to make full use of their attractive properties like chemical stability, low dielectric loss good dielectric strength and high electrical insulation. Two promising candidates of the group of polymeric materials, polymethyle methacrylate (PMMA) and polystyrene (PS) in pure and blended forms have been chosen in the present investigation for systematic characterization studies. A few studies have been carried out on the optical, dielectric and electrical conduction properties of PMMA and PS by various researchers (1, 6, 7). From the literature reports of researchers, it was found that only limited studies are carried out on mixed, blend, hybrid thin films. Therefore attempts in the present studies are made to understand pure PS, PMMA and blend thin films with respect to optical properties.

EXPERIMENTAL WORK

A number of materials like glasses, ceramics, and quartz are available and used as thin film substrates. One of these materials is glass. It has the maximum surface smoothness and is also optically plane [8].

MPM STRUCTURE

Metal – Polymer – Metal (MPM) sandwich structures were formed onto the glass substrates with the insulation layer in between the two metals electrodes by making use of suitable masks as shown in fig. 2.3. The fabricated MPM structure and its vertical cross sectional view are shown in fig. 2.4. The electrode material should be such that it does not react with the dielectric film and should have good adhesion with the substrate and also a low electrical resistance. Metals like gold, silver, copper and aluminum are used as electrode materials of these aluminium has been observed to posses all the desirable while the other materials are found to be lacking in one or other. Hence aluminium has been used as the electrode material in the present study.

OPTICAL PROPERTIES

The knowledge of the optical properties of thin solid film is very important in many scientific, technological and industrial applications in the field of devices, based on optoelectronics, for example their excellent transmittance in the spectrum along the low electrical resistivity underline the importance of the characterization of the material through the determination of the optical constants as well as the type of the optical transition. The optical behaviour of thin film concerns mostly measuring the optical quantities like transmittance (T), reflectance (R), absorbance (A) and then applying these measurements to find out the various optical constants such as the extinction coefficient (K_f), absorption coefficient (α) and refractive index (n_f) of the films. The optical absorption studies have been used to gain information's regarding the electronic structure of solids.

RESULTS AND DISCUSSIONS

The optical transmittance of the polymer films, namely pure and blended PS and PMMA films were recorded in the wavelength range 200-500 nm, using UV – VIS – NIR double beam spectrometer. This instrument measures the ratio of the radiant power of two electromagnetic beams over a large wavelength region. The well collimated unpolarised light was adjusted to be incident on the film. The intensity of

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transmitted beam was measured. The optical constants like refractive index, the extinction coefficient and the coefficient of absorption have been evaluated from the calculated transmittance values, the wavelength of incident light and thickness of the film.

The measured normal transmittance spectra of polymer films i.e., pure PS, PMMA, blend PS and PMMA films are shown in Fig 1. It is revealed from the figure that the transmittance increases as wavelength increases up to 17% for pure PS film. In case of pure PMMA film, the transmittance is 25%, the transmittance is nearly 70% for PMMA 25 sample, where as transmittance is nearly 90% for sample PMMA 75. The transmittance for PS and PMMA taken in equal ratio i.e., PMMA 50, it is 8%. The transmittance of the films increases with increase in wavelength [9], which indicates that these films are slightly transparent in the IR region.

The wavelength dependence of the extinction coefficient (k_f) is shown in Fig 2. The extinction coefficient was found to increase with increase in wavelength. It is clear that the extinction coefficient decreases from .094 to .046 with increase in wavelength from 400-800 nm, in the case of PMMA 75 sample. The reason may be due to the presence of excess amount of PMMA in PS. The extinction coefficient increases as wavelength increases was observed for pure PS, PMMA, and blend PMMA 25, PMMA 50 films.

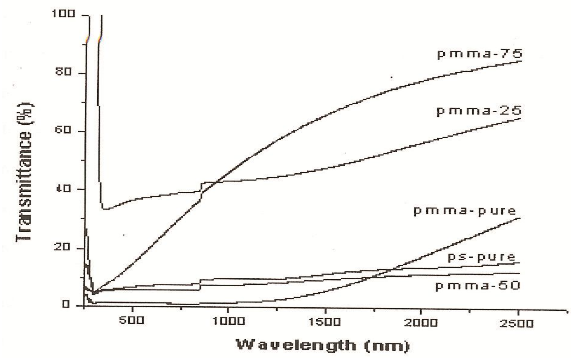

Fig. 1 Transmission spectra of pure PS and PMMA and blend (PMMA-25, 50 and 75) films

The wavelength dependence of the absorption coefficient ( ) is shown in Fig. 3. The presence of PMMA in PS decreases the absorption coefficient as the wavelength increases. This variation of absorption coefficient can be explained similar to the variation of the extinction coefficient, as done by Lamies Shahada et al [11].

The values of n, k_f and α are determined from the formulae given in section 2.3. The spectral distribution of refractive index ‘n’ for pure PS, PMMA and blend (PMMA 25, PMMA 75, PMMA 50) films respectively are shown in Fig 4. The refractive indices are wavelength dependent [12]. For pure PS film, the refractive index increases from 1.62 to 1.76 steadily and then decreases down to 1.59. In case of pure PMMA film, the refractive index slightly increases from 1.58 to 1.67 and decreases slowly to 1.57 as wavelength increases. When PMMA is blended with PS i.e., in PMMA 25 sample the refractive index increases from 1.59 to 1.65 and decreases gradually to 1.61, to reach stability. When compared with PMMA 25 and PMMA 75 blend films, PMMA 50 film reaches the maximum refractive index value in lesser wavelength region [13], and also more stable. The comparative graph for refractive index of all the samples is shown in Fig 4.

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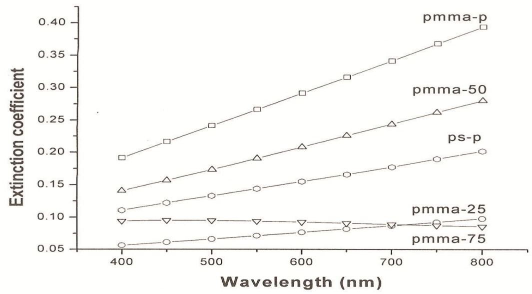

Fig. 2 Extinction coefficient of pure PS and PMMA and blend (PMMA-25, 50 and 75) films

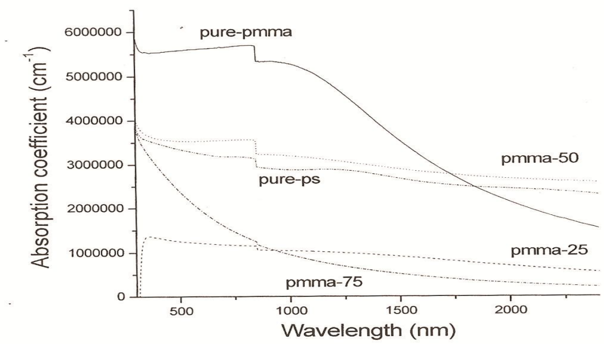

Fig. 3 Absorption coefficient of pure PS and PMMA and blend (PMMA-25, 50 and 75) films

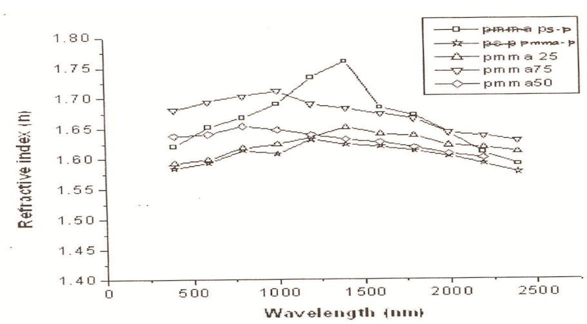

Fig. 4 Comparative graph for Refractive index Vs Wavelength for all films

CONCLUSION

The structure, optical properties of solution grown pure polystyrene (PS) and polymethyle methacrylate (PMMA), blend films have been investigated in detail in the present study. The important results are summarized below.

1. The transmittance of PS and PMMA films increases with wavelength and it will indicate that these films are transparent in IR region of Electromagnetic spectrum.

2. The extinction coefficient increases as the wavelength increases for the thin film studied.

3. The RI of thin films PS and PMMA and blend exhibited dependence on the wavelength of incident light. The mixed thin film show stable in value in low wavelength region.

4. All the films PS, PMMA and blended show transparence performance optically and can be further exploited for application in electronics and electrical industry.

Thus the present investigation provides valuable data on, optical and electrical conduction of solution grown pure and blend, PS and PMMA films. It is believed that data present in this work, along with the other data available in the literature, will be very much useful for the exploitation of these films in a variety of applications.

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REFERENCES

[1] N.G.Belsare and V.S.Deogaonkar, Indian J. of pure Appl. Phys., 36 , 280.1998
[2] Lamies Shahada, M.E. Kassem, H.I. Abdelkader and H.M. Hassan, J.Appl. Polymer Science. 65 ,1653.1997
[3] Erik wold, Johannes Bremer and Ola Hunderi, J. of Polymer Science Part B: Polymer Physics, 31 ,579.2003.

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[4] S.C.K. Misra, N.N. Belda, S.S. Pandey, M.K. Ram, T.P. Sharma, B.D. Malhotra and Subhas Chandra, J. of Polymer Science, 50 411,2003
[5] Suresh chand, J.P. Agarwal and P.C. Mahendran. Thin solid films 99 ,351,1983
[6] P.K. Barny, Thin Solid Films, 152, 99.1987
[7] G.K. Narula, Rashmi and P.K.C. Pillai, J. Macromol. Sci. Phys., E8 ,2,1989
[8] R.E. Berry, P.M.Hall and M.T.Harris, Thin Films Technology.
[9] A.P. Monkman, D. Bloor and G.C. Stevens, Journal of Physics. D: Appl. Physics 20, 1337.1987
[10] Wen-Chang Chen, Samson, A. Jenekhe and S. Meth. Journal of Polymer Science: Part B: Polymer Physics, 32 , 195.1994
[11] Lamies Shahada, M.E. Kassem, H.I. Abdelkader and H.M. Hassan, J. of Appl. Polymer Science, 65 ,1653.1997
[12] H.R. Brown, J. Phy Sci. Polmer physics Edition, 17 ,1417.2003
[13] Erik Wold, Johames Bremer and Ola Hunderi, J. of Poly Sci. Part B: Polymer Physics, 31, 579.2003.