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A Comparative FTIR Analysis of Stannous Chloride ($SnCl_2$) Doped Poly Methyl Methacrylate (PMMA) and Poly Ether Sulfone (PES) Composite Films

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Abstract: ***Three solid composite films of Poly-methyl-methacrylate (PMMA) doped with different concentration (2%, 4% and 8%) of $SnCl_2$ of thickness (~100µm) and three flexible thin films of PES doped with different concentration (2%, 4% and 8%) of $SnCl_2$ have been synthesized employing the solution cast technique. The FTIR studies of the prepared films ascertains that $SnCl_2$ nano particles are well dispersed in the polymer and are coordinated to carbonyl and methaoxy oxygen of the polymer.***
Keywords: PES- $SnCl_2$ Composite films, PMMA- $SnCl_2$ Composite films, FTIR.

I. INTRODUCTION

The insulating polymers, poly (methyl methacrylate) (PMMA) and Poly ether sulfone (PES) are good insulating polymers transparent in nature. However, on insertion of organo-metallic compound in them they become conducting in nature retaining their transparency. These organo-metallic polymer composite then create a new class of materials termed as Transparent conducting Polymer oxide composites (TCPOs) which have low absorption of light and are electrical conductive materials. They are usually prepared with thin film technologies and used in opto-electrical devices such as solar cells, displays, opto-electrical interfaces and circuitries. Infrared (IR) spectroscopy is a useful technique for characterizing these materials and providing information on the molecular structure, dynamics, and chemical bonding of such composites. In the present work, the authors have prepared three solid composite films of Poly-methyl-methacrylate (PMMA) doped with different concentration (2%, 4% and 8%) of $SnCl_2$ and five flexible thin films of PES doped with different concentration (2%, 4% and 8%) of $SnCl_2$ of thickness (~100µm) using the solution cast technique. The molecular structure of these prepared samples have been analyzed by obtaining the infrared (IR) spectra using Perkin Elmer Spectrum Version 10.4.00 FTIR spectrophotometer in the region 400–4000 cm^{-1}.The FTIR studies of the prepared films ascertains that $SnCl_2$ nano particles are well dispersed in these polymer and are coordinated to carbonyl and methaoxy oxygen of the polymer.

II. METHODS AND MATERIALS

A. Materials

Stannous chloride (SnCl2.2H2O - analytical reagent grade , dehydrated purified and Dichloromethane (purity of 99.8%) was purchased from Merck Specialties Private Limited, Mumbai; Polymethylmethacrylate (PMMA) granules and Poly ether sulfone (PES) granules were purchased from M/s Gadra Chemicals, Bharuch. Ethanol (99.9%) procured from Changshu Hongsheng Fine chemicals,. All chemicals were used as received. In fact the materials PMMA and PES act as host matrix and tin chloride as filler.

B. Sample Preparation

Films of pure PMMA and its composites with different weight percent of $SnCl_2.2H_2O$ were prepared by solution casting technique. A predetermined amount of granular PMMA is measured and dichloromethane is added as a solvent. The molten PMMA is stirred uniformly on a magnetic stirrer for four hours and to this prepared solution 5 ml of ethanol and different concentration of $SnCl_2.2H_2O$ (2%, 4% and 8% by weight) are added. The solution is stirred so that polymer and $SnCl_2.2H_2O$ dissolve completely to yield a clear solution. The solution is then poured into a glass petri dish of diameter 6 cm washed thoroughly with hot water and then cleaned with acetone. The solution spreads uniformly in all direction in the petri dish which is kept freely floating over a pool

of mercury so as to achieve perfect levelling and uniformity in the thickness of the film. The solvent was allowed to evaporate slowly at ambient temperature under atmospheric pressure for almost twenty four hours. The dried samples are peeled off by tweezers clamp. Transparent flexible nanocomposite polymer films of thickness around 100 µm are obtained. The films of pure Poly ether sulfone (PES) and its composites with different weight percent (2%, 4% and 8% by weight)of $SnCl_2.2H_2O$ of thickness around 100 µm were prepared by solution casting technique in a similar fashion.

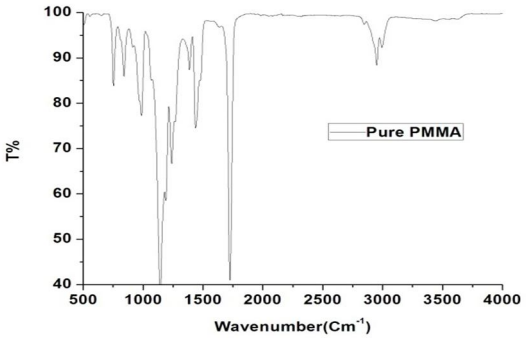
C. Characterization

The infrared (IR) spectra of the polymer metal complexes were recorded on a Perkin Elmer Spectrum Version 10.4.00 FTIR spectrophotometer in the region 500–4000 cm^{-1}.

III. RESULTS AND DISCUSSION

FTIR spectra which represent the molecular fingerprint of the samples are depicted in figures 1 and 2 respectively for the pure PMMA and pure PES and in figures 3-5 respectively for their stannous composites with different concentrations.

As shown in figure 1, the structure of pure PMMA is characterized by the vibration bands at 1725 cm^{-1} assigned to C=O stretching, other vibration mode appearing at 2951 cm^{-1} corresponding to the C–H stretching of the methyl group (CH_3). The bands at 1384 and 1435 cm^{-1} are ascribed with C–H symmetric and asymmetric stretching modes, respectively. The 1236 cm^{-1} band is assigned to torsion of the methylene group (CH_2) and the 1191 cm^{-1} band corresponds to vibration of the ester group C–O, while C– C stretching bands are between 986-481 cm^{-1}



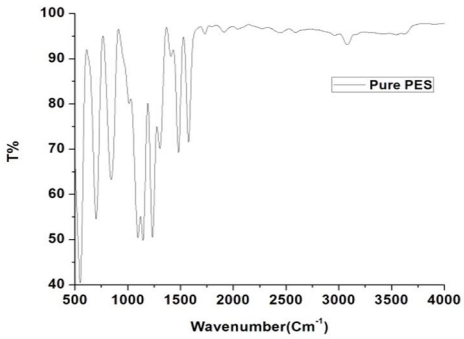
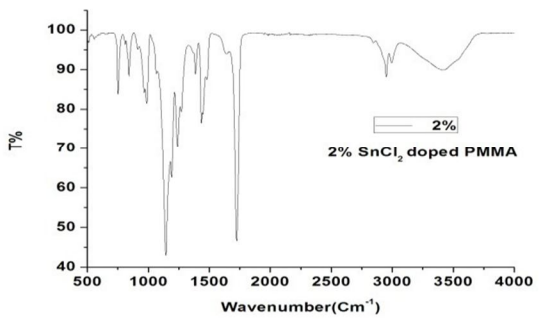


Fig.1: FTIR Spectrum for pristine PMMA Fig.2: FTIR Spectrum for pristine PES

The structure of pure PES includes four benzene rings, an ether bond and a sulphone structure. The PES is characterized by the vibration from 548.39 cm^{-1} to 2591.56 cm^{-1} bands assigned to various skeletal and acoustic modes of vibrations of the functional groups as shown in figure 2. The three peaks appearing at 1409, 1481 and 1576 correspond to the aromatic skeletal stretching vibrations of benzene rings. The C-O asymmetrical stretching is characterized by 1012 cm^{-1} and 1096 cm^{-1} vibration modes. The peak appearing at 1303.87 cm^{-1} and 1234 cm^{-1} corresponding to the $C=SO_2=C$ asymmetrical stretching of ether bond. The sulphone structure leaves its footprint at 548, 700 and 843 cm^{-1} and O-H aliphatic and aromatic vibrational signatures can be observed at 2042,2591 and 3079 cm^{-1}.

The FTIR analysis of the composite sample films of stannous chloride doped PMMA and PES has also been carried out.



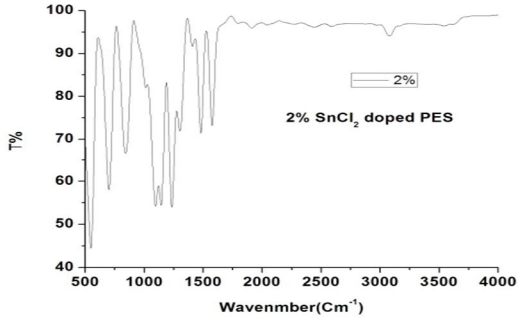


Fig.3: FTIR Spectrum (a) for 2% $SnCl_2$ doped PMMA (b) for 2% $SnCl_2$ doped PES

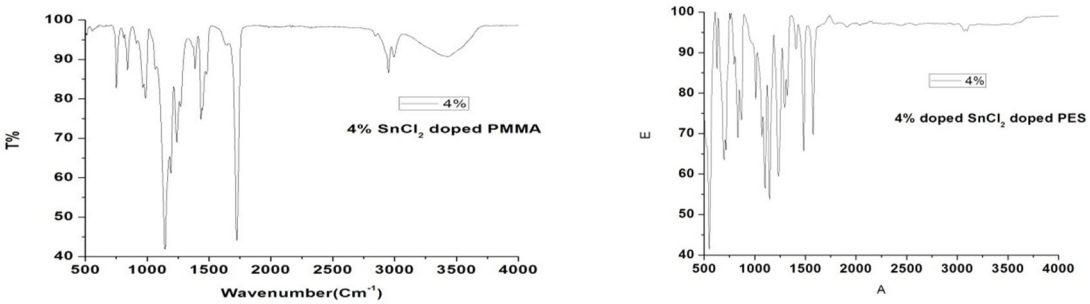


Fig.4: FTIR Spectrum (a) for 4% $SnCl_2$ doped PMMA (b) for 4% $SnCl_2$ doped PES

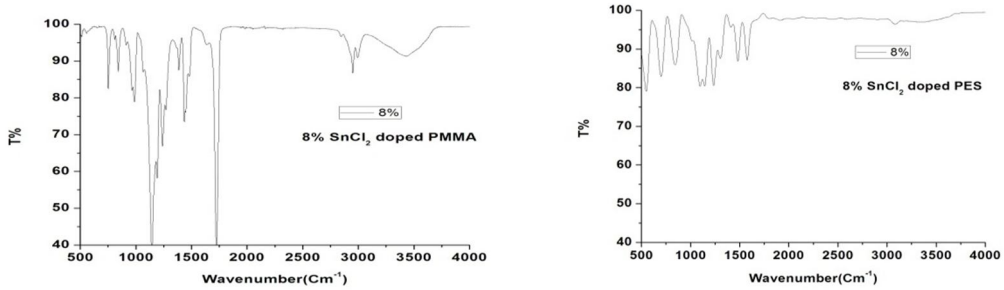


Fig.5: FTIR Spectrum (a) for 8% $SnCl_2$ doped PMMA (b) for 8% $SnCl_2$ doped PES

However with the incorporation of stannous chloride in the composites of PMMA and PES interesting observations are unfolded. There is an appearance of a new peak observed at 3456 cm^{-1} for PMMA stannous chloride composites indicating origin of new functional group due to formation of composite. No such new peaks have been seen to be originating in the PES Stannous chloride compound suggesting no formation of new functional group in these composites. A shift in peaks is clearly observed in case of PES composites but not in case of PMMA composites. Further in composites of both the polymeric materials the stretching peaks have become apparently wider which reveals that the chemical interaction has taken place. Further, in both the cases the intensity of vibrational bands also decreases with increase in concentration of stannous chloride. .

IV. CONCLUSION

In this work, composite sample films have been synthesized by adding tin chloride to PMMA and PES using the solution casting technique. The molecular structure properties have been studied by using FTIR. The structure of PMMA Stannous chloride composites shows origin of new peak, whereas the PES composites show shift in observed peaks. In both the cases peak broadening and decrease in intensity is seen with the increase in concentration of $SnCl_2$

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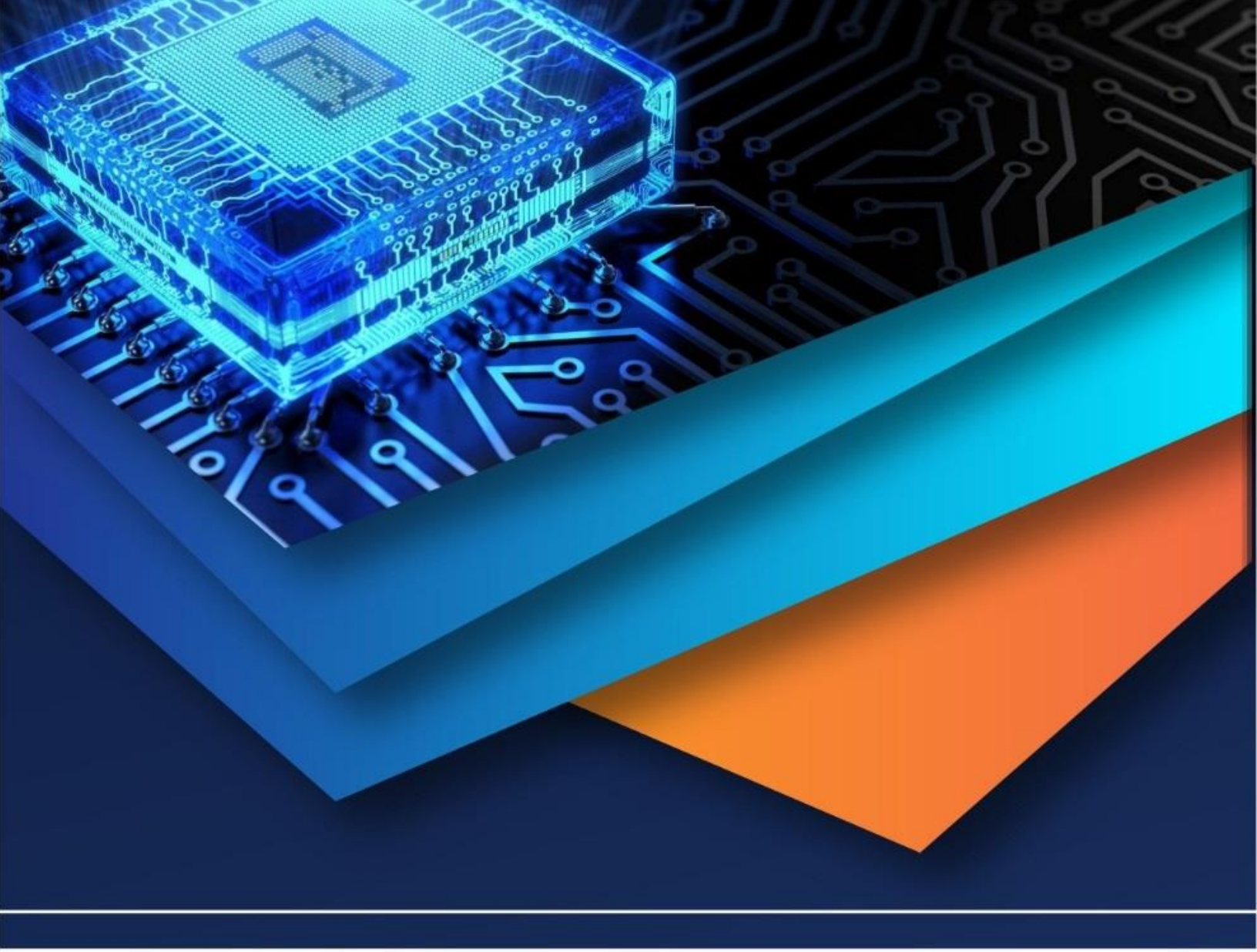

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