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Preparation and Characterization of 4:1 (EC-PVC) Ethyl Cellulose - Polyvinyl Chloride Polyblends Thin Films[1]

Welekar N.R., Wasnik T.S., Lamdhade G. T.
Department of Physics, Vidya Bharati Mahavidyalaya, C.K. Naidu Road, Camp, Amravati.-444602

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ABSTRACT

The present study is focused on preparation and characterization of 4:1 (EC-PVC) Ethyl Cellulose - Polyvinyl Chloride polyblends thin films of pure and doping with different weight ratio of Salicylic Acid (SA) and the isothermal evaporation technique used for its preparation. In order to investigate properties of the prepared samples were characterized by Fourier Transform Infrared Spectroscopy (FTIR) techniques.

Keywords: *4:1 (EC-PVC); Ethyl Cellulose; Polyvinyl Chloride; FTIR .*

INTRODUCTION:

In recent years, considerable progress has been made to enhance the electrical conductivity, electrochemical and mechanical stability of these polymer electrolyte materials to be utilized for various applications like solid state batteries, fuel cells, sensors, super capacitors, electro chromic display devices, photo electrochemical solar cells etc. [1-4]. The conducting polymer composites and blends have attracted the attention of material researchers, with increase in interest in obtaining properties that are intermediate between those of homo polymers [5,6]. Generally polyvinyl chloride (PVC) is being used for the consumer products like cables, pipes, window frames, packaging bottles, Hit cards and audio recording. It is also used in car interiorsand in hospital as medical disposables. The presence ofchlorine in the PVC structure is the reason of its betterproperties like fine resistance and durability. Dielectricproperties and surface morphology of proton irradiatedferric oxalate dispersed PVC films has been studied [7]. A lightweight, rigid plastic in its pure form, it is also manufactured in a flexible "plasticized". Polyvinyl chloride (PVC) is one of the most important commercial polymer that have wide range of applications[8].

Due to accessibility to basic raw materials and to its properties incorporating plasticisers, the rigid PVC makes the soft PVC products and it has been used in cable and wire covers, chilldren toys and medical devices. [9] PVC's relatively low cost, biological and chemical resistance and workability have resulted in it being used for a wide variety of applications. It is used for sewerage pipes and other pipe applications where cost or vulnerability to corrosion limits the use of metal. With the addition of impact modifiers and stabilizers, PVC scrap has become a popular material for

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window and door which is 50% less than the cost of wooden window and door. By adding plasticizer, it can become flexible enough to be used in cabling applications as a wire insulator. It has been used in many other applications.

Ethyl cellulose is thermoplastic water insoluble, organic solvent soluble cellulose either the result from the reaction with ethyl chloride with alkali cellulose has wide variety uses because ethyl cellulose is tough stable to heat, flexible even at very low temperature, soluble in wide range of organic solvent, widely compatible with waxes, resins and plasticizers. Ethyl cellulose tends to harden and toughen most composition in which it is compatible. It is versatile, in that it can be formulated for many varied uses of tailored to specific uses.

EC is used for many application due to its activeness [10,11] EC is already extensively used for films thickening agents [12,13]. It is compatible with other polymers and plasticizers and can therefore be used to make waterproof films [14,15].

It is resistant to dilute and concentrated alkali and to salt solutions. The excellent electrical properties of ethyl cellulose combined with its good thermo-stability, outstanding flexibility, and toughness account for its use in cable lacquers. It is also used in plastics for electrical insulation [16-19]. Ethyl cellulose is used as an ingredient of lacquers, gel lacquers, melts, varnishes, adhesive, latexes and pharmaceuticals coating. The present study is focused on preparation and characterization of 4:1 (EC-PVC) Ethyl Cellulose - Polyvinyl Chloride polyblends thin films of pure and doping with different weight ratio of Salicylic Acid (SA) and the isothermal evaporation technique used for its preparation.

EXPERIMENTAL TECHNIQUES

The two polymers EC and PVC were taken in the different weight ratios 4:1 dissolved in a common solvent Tetrahydrofuran (THF). Then the poly-blend films of EC-PVC pure and doped with salicylic acid (SA) in different weight percentage (5%, 10%, 15%, 20%, 25%) were prepared. The solution was kept for 3-4 days to allow polymers to dissolve completely to yield uniform solution. A glass plate (15X15 cm) thoroughly cleaned with water and later with acetone was used as substrate. To achieve perfect levelling and uniformity in thickness of films, a pool of mercury was used. The solution was poured on glass plate and allowed to spread uniformly in all direction on substrate. The whole assembly was placed in a dust free chamber at room temperature. The solvent in the solution was thus allowed to evaporate completely and get air-dried. The film on the glass substrate was then removed and cut in to small pieces of suitable size. In this way the films were prepared by isothermal evaporation technique [20-23] given in the following flow chart Fig.2.1. Further it was dried for three days to remove any traces of solvent.

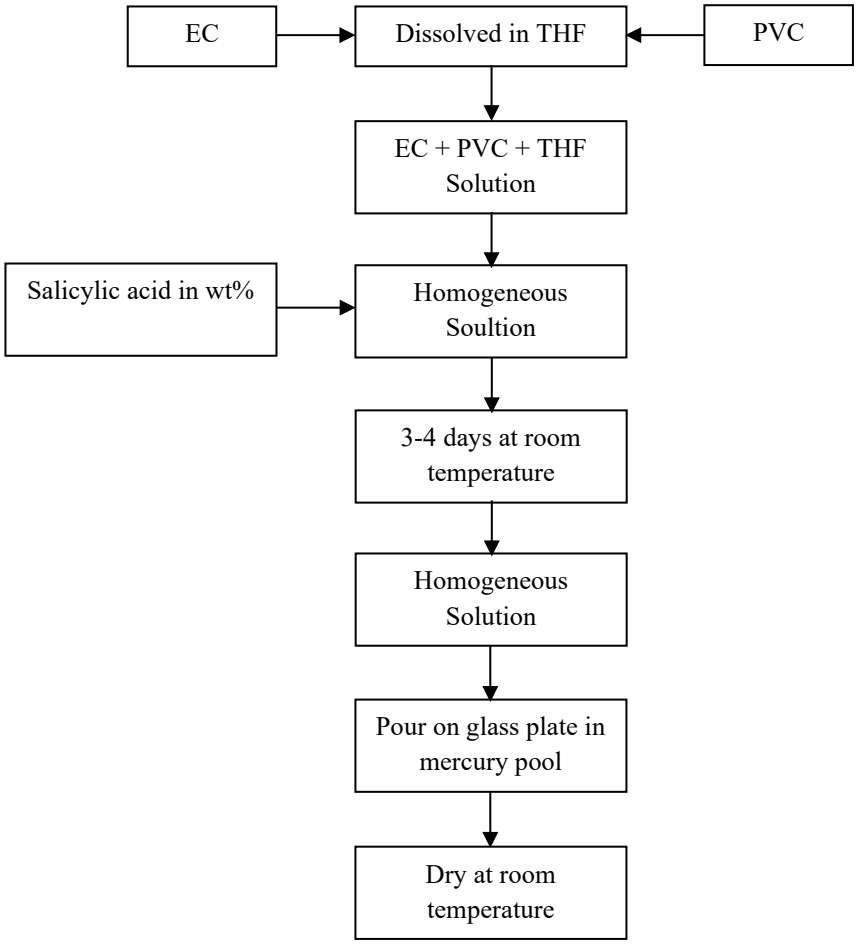

Fig. 2.1 : Flowchart of Preparation of EC-PVC Polyblend thin films

The present study has been carried out with the following samples shown in table 2.1

Table 2.1 Sample Code of EC-PVC Polyblend thin films

1)	EC-PVC + 0% Salicylic Acid	4:1 EC-PVC SA(0)
2)	EC-PVC + 5% Salicylic Acid	4:1 EC-PVC SA(5)
3)	EC-PVC + 10% Salicylic Acid	4:1 EC-PVC SA(10)
4)	EC-PVC + 15% Salicylic Acid	4:1 EC-PVC SA(15)
5)	EC-PVC + 20% Salicylic Acid	4:1 EC-PVC SA(20)
6)	EC-PVC+ 25% Salicylic Acid	4:1 EC-PVC SA(25)

RESULTS AND DISCUSSION

Fourier Transform Infrared Spectroscopy (FTIR)

In the present work IR spectra of all samples were recorded on Shimadzu IR Affinity Model. If two polymers are completely incompatible, each individual polymer does not recognize, in infrared spectral terms, the existence of the other in the blend. On the other hand, if the polymers are compatible, there should be considerable differences between the infrared spectrum of the blend and the spectra of the pure components. These differences would be derived from chemical interactions resulting in band shifts and broadening. In this study the FTIR of samples containing EC-PVC in ratios i.e. 4:1 doped and undoped with SA with the resolution of the measurements was 4 cm^{-1}**.**

In Fig. 3.1, FTIR spectroscopy was used to examine the interaction between 4:1 EC–PVC blend in which Fig. 3.1(a) shows interaction between 4:1 EC–PVC blend without dopant. The absorption bands at 2965 cm^{-1} and 2890 cm^{-1} are assigned to asymmetric and symmetric stretching bond of C–H in PVC respectively. The peak at 1178 cm^{-1}, 1998 cm^{-1} are attributed C–O–C stretching and C–H bending in EC respectively. The peak at 1738 cm^{-1}, 607 cm^{-1}, 1265 cm^{-1}, 1310 cm^{-1} are attributed to C=O stretching, C–H wagging, bending of C–H near Cl, CH_2 deformation in PVC respectively.

Fig. 3.1(b-f) shows FTIR spectroscopy used to examine the interaction between 4:1 EC–PVC blend with dopant. The peak at 1177 cm^{-1}, 1175 cm^{-1}, 1175 cm^{-1}, 1170 cm^{-1}, 1168 cm^{-1}, are attributed to C–O–C stretching of EC in cases of 4:1 EC-PVC SA (5), EC-PVC SA (10), EC-PVC SA (15), EC-PVC SA (20), EC-PVC SA (25) respectively. The peak at 1614 cm^{-1}, 1554 cm^{-1} for EC-PVC SA (5) are assigned to C=C stretching in SA. Peak at 762 cm^{-1}, EC-PVC SA (5) is attributed to C–H bending in SA. As concentration of SA increases peak at 1614 cm^{-1}, 1554 cm^{-1}, 762 cm^{-1} shifted to higher wavelength.

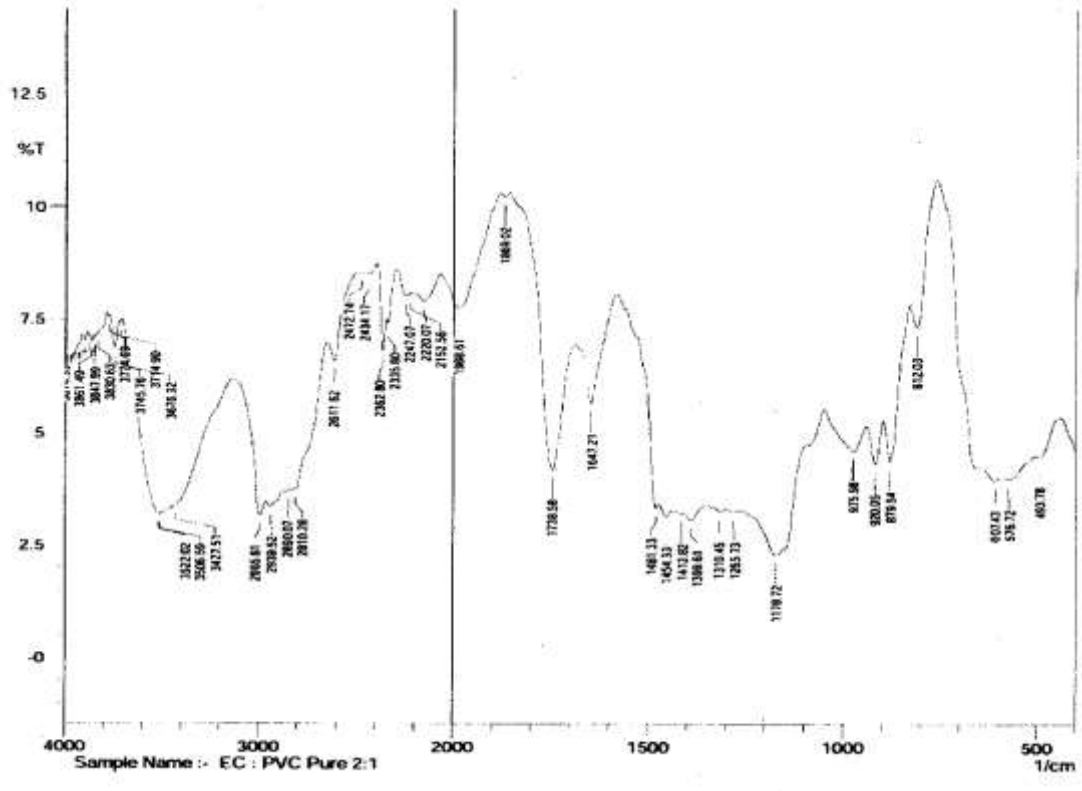

Fig. 3.1 (a) 4:1 EC-PVC SA(0)

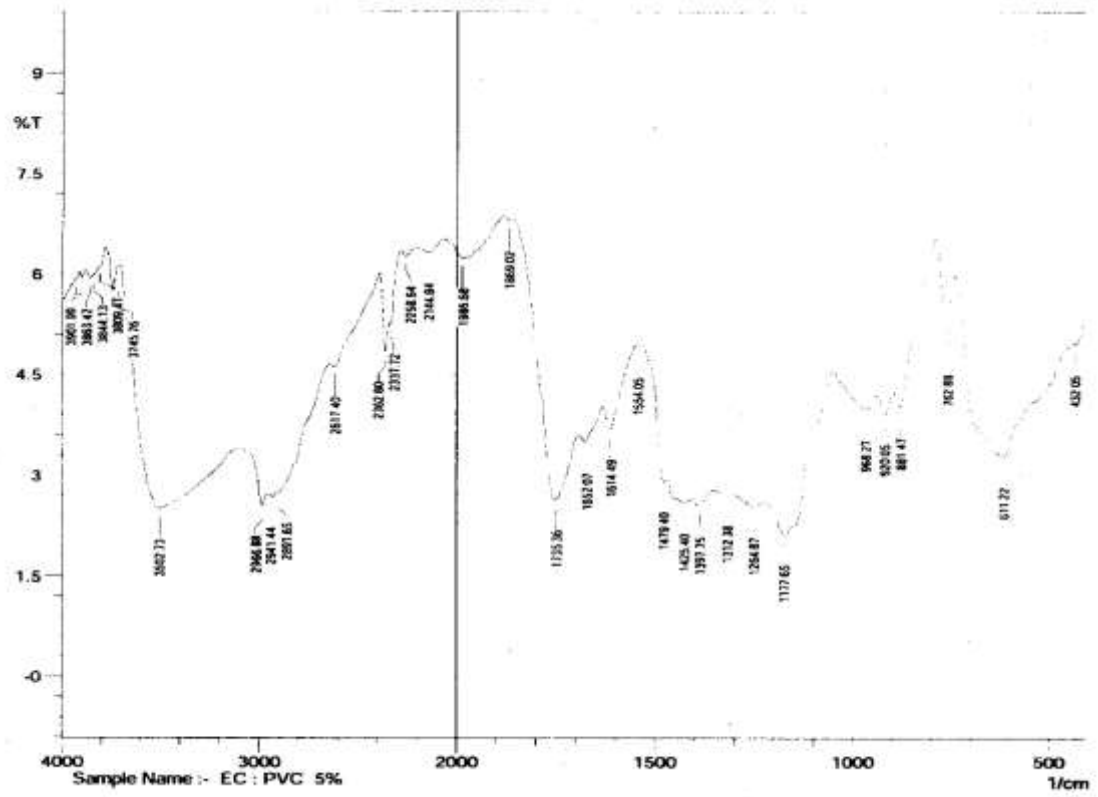

Fig. 3.1 (b) 4:1 EC-PVC SA(5)

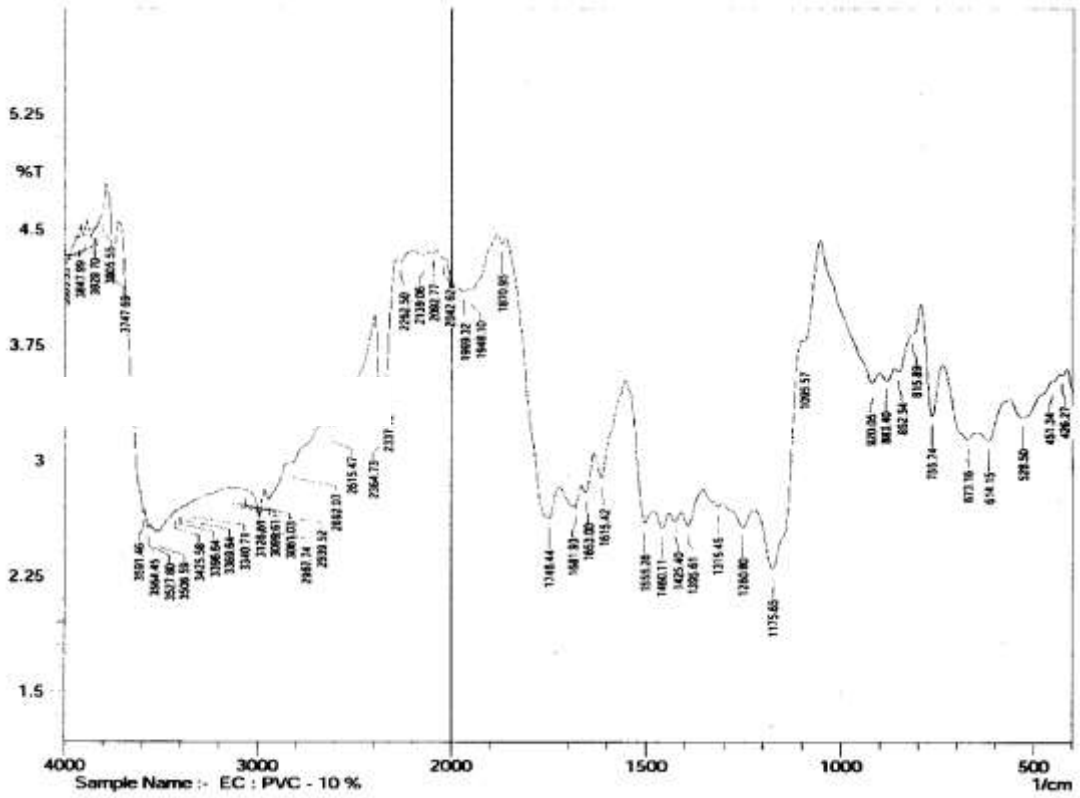

Fig. 3.1 (c) 4:1 EC-PVC SA(10)

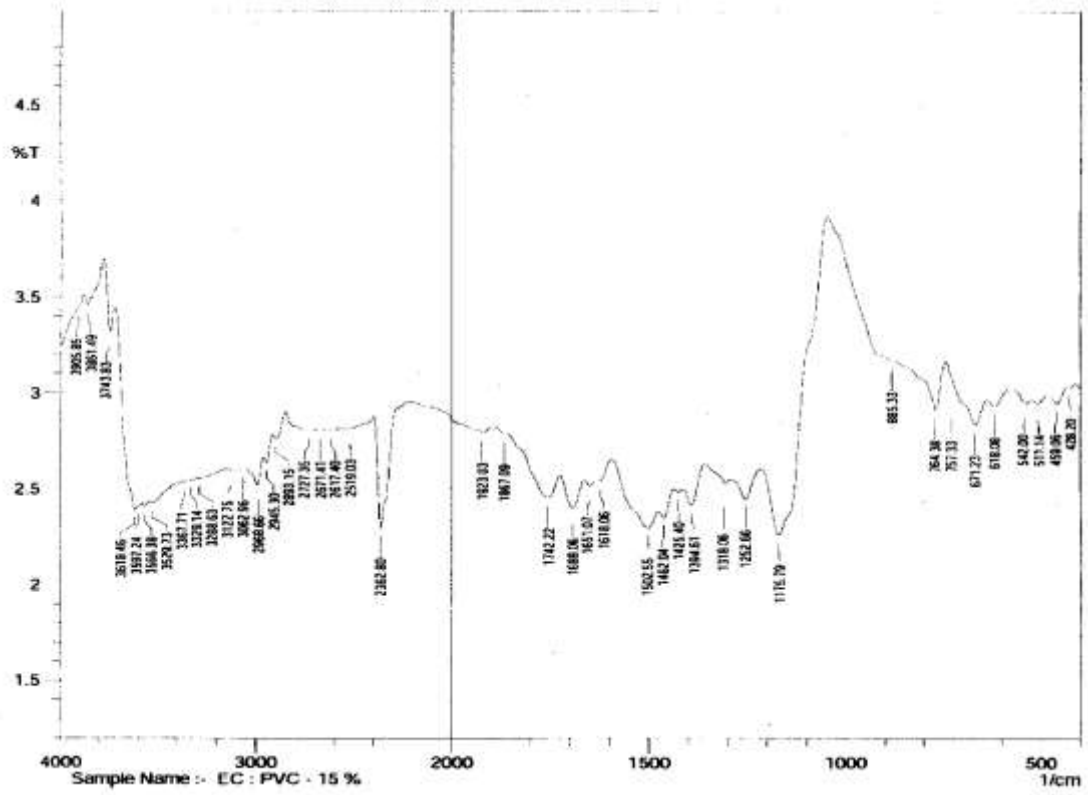

Fig. 3.1 (d) 4:1 EC-PVC SA(15)

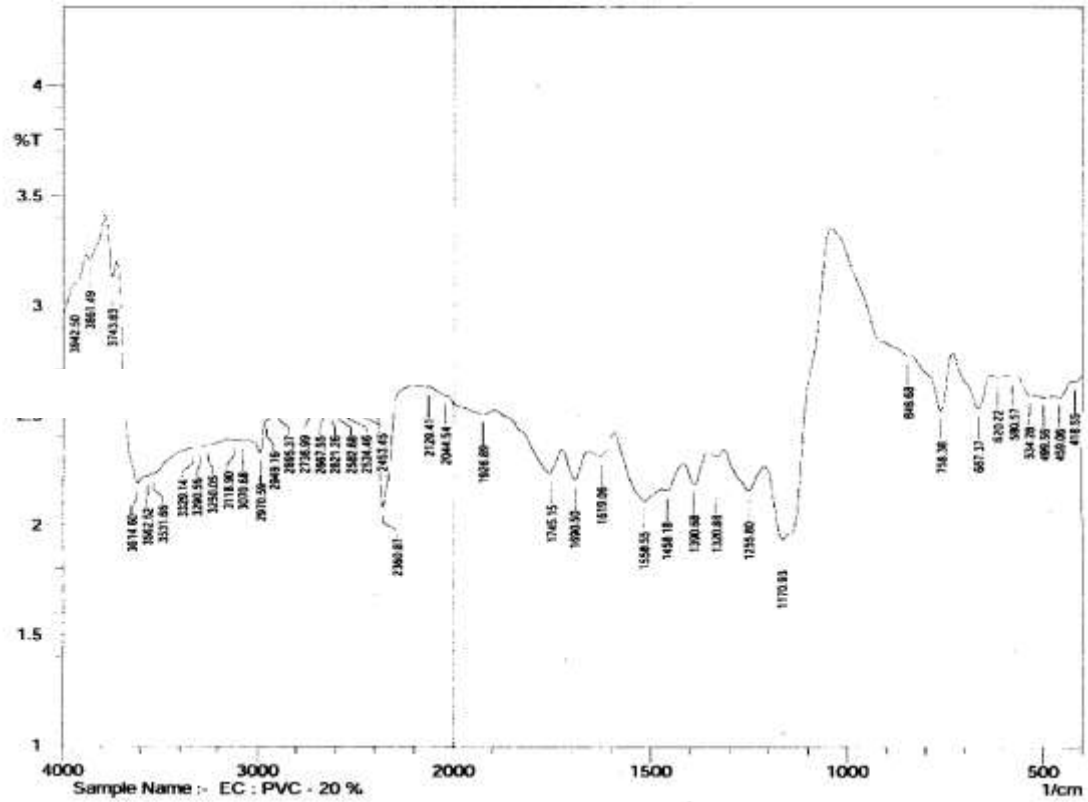

Fig. 3.1 (e) 4:1 EC-PVC SA(20)

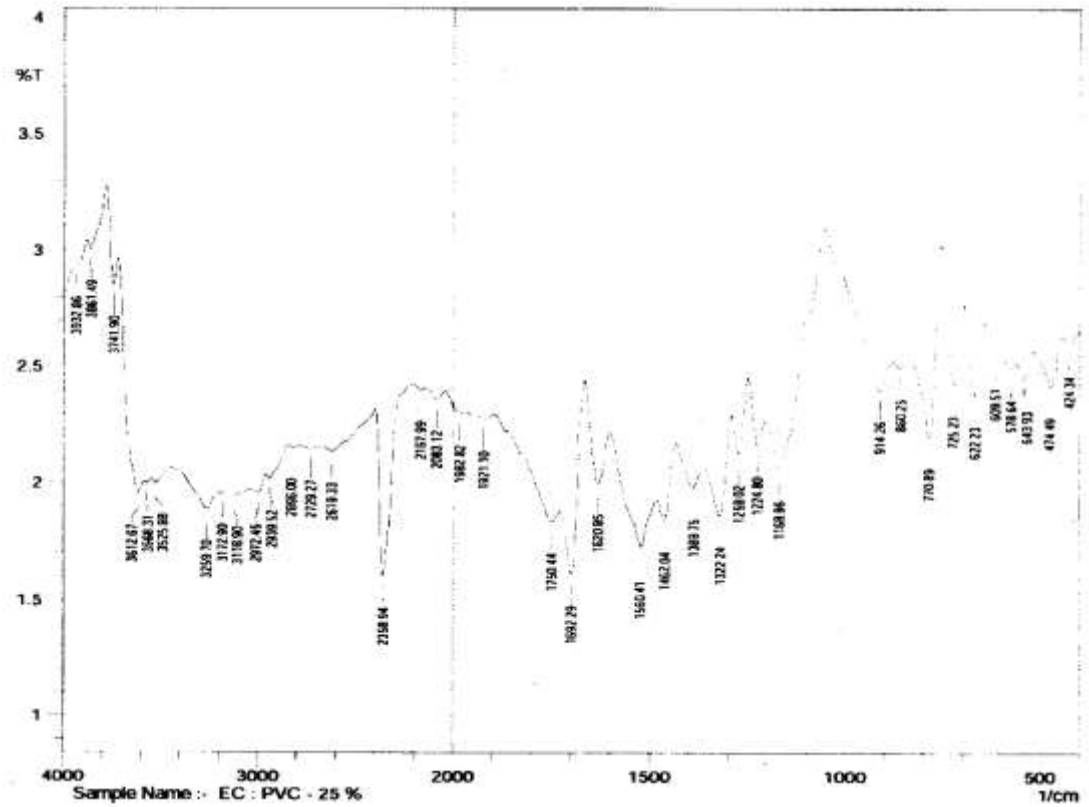

Fig. 3.1 (f) 4:1 EC-PVC SA(25)

Fig. 3.1 (a-f) : FTIR Spectra of 4:1 EC-PVC System

Standard Vibrations in EC and PVC

Table 3.1, 3.2 and 3.3 consist of major infrared bands in (EC - PVC) blends doped with SA.

Table 3.1 Major infrared bands of Ethyl Cellulose (EC)

Wave Number (cm^{-1})	**Assignment**	**References**
1052	C–O–C stretching	[24]
1081	C–O Stretching	[25]
1369	C–H bending	[24]
1324	C–O–H Stretching	[25]
1610	C=O Carbonyl Stretching	[25]
2917	CH_2 asymmetric Stretching	[25]
2880 & 2970	C–H Stretching	[24]

Table 3.2 Major infrared bands of Polyvinyl Chloride (PVC)

Wave Number (cm^{-1})	**Assignment**	**References**
2972 & 2910	CH_2 asymmetric Stretching	[26]
1717	C=O	[27]
615, 700	C–Cl Vibration	[27]
1272	C–H rocking	[27]
1250	C–H bending	[26]
1325	CH_2 deformation	[27]
2960	C–H stretching	[28]
1074	C–H rocking	[29]

Table 3.3 Major infrared bands of Salicylic Acid (SA)

Wave Number (cm^{-1})	**Assignment**	**References**
2999-3004	C–H Stretching	[30]
1652-1670	C=O asymmetric Stretching	[31]
759-669	C–H bending	[30]
1386	C=O symmetric Stretching	[31]
1324	O–H bending	[30]
3233	O–H stretching	[31]
1296	C–O stretching	[31]

CONCLUSIONS

Fourier Transform Infrared Spectroscopy (FTIR) is the most widely used method to characterize polymer structure. It was used to study hydrogen bonding in polymer blends. From spectra, it was observed that in blends all important characteristics peaks of virgin EC and virgin PVC reappear, that indicates formation of EC-PVC blends. After doping blends shows some extra peaks which show presence of Salicylic acid. As doping concentration increases peak shifted to higher wavelength but its intensity decreases in the blends. From the FTIR spectra recorded on these films, several

changes in the absorption bands, appearance of new bands along with changes in the intensities of existing peaks and / or their disappearance directly indicates the complexation of EC-PVC polymer blend with the Salicylic acid.

REFERENCES

1. Chao.S, Wrighton. M.S, (1987); *Journal of American Chem*. Soc., 109, 6627.
2. Gray F.M, (1991); *Solid polymer electrolytes, Fundamentals and Technological Applications*, VCH, New York
3. Stinson. S , Chem and Eng. News, 75, 17, (1997).
4. Fuller. J , Breda A.C., Carlin R. T. Electrochem., Soc, 144, 4 ,(1997).
5. Basic definitions of Terms relating to polymers, International Union of Pure and Appl.Chem. London Butter Worths Publishers, London , (1974).
6. Gold. V, Loening. K.L, McNaught. A.D and Sehmi. P, (1987); *Compendium of Chemical Terminology / IUPAC Recommendations*, Black Well Scientific Publications, Oxford Inc.Palo Alto, Calif.
7. Sarto .C, (2009); *Application of Solution Protein Chemistry to Biotechnology*; Roger L. Lundblad (Ed.) Protein Science Series CRC Press, Taylor & Francis Group, Boca Raton, FL USA.
8. Q. Wang and B.K. Storn; *Polymer Testing,* 24, 290, (2005).
9. B. Balakrishnan and A. Jayakrishnan, (2005); Chemical modification of poly(vinyl chloride) using poly(ethylene glycol) to improve blood compatibility, in *Trends in Biomaterials and Artificial Organs,* 18,2, 230-236.
10. Kirk-Othmer Encyclopedia of Chemical Technology. 4th ed. Volumes 1: New York, NY. John Wiley and Sons, p. 933, (1991).
11. Kumar, P. K. Khare and A. Pal, (2018); 11th International Journal of Advance Research in Science and Engineering, 7, 3, (2018).
12. X. Su, Z. Tang, K.B. Tan, J. Chen, J. Huang and Q. Li, (2020); Preparation and Characterization and Ethyl Cellulose Film Modified with Capsaicin. *Carbohydr. Polym.*, 241, 116259.
13. J. Zhu, X.T. Dong, X.L. Wang and Y.Z. Wang, (2010); Preparation and Properties of a Novel Biodegradable Ethyl Cellulose Grafting Copolymer with Poly(p-Dioxanone) Side–Chains. *Carbohydr. Polym.*, 80, 350-359.
14. Hosseini, S. Ramezani, M. Tabibiazar, M. Ghorbani and H. Samadi Kafil, (2021); Fabrication of Cumin Seed Oil Loaded Gliadin-Ethyl Cellulose Nanofibers Reinforced with Adipic Acid for Food Packaging Application. *Food Packag. Shelf Life*, 30, 100754.
15. P. Shi, Y. Zuo, Q. Zou, J. Shen, L. Zhang, Y. Li and Y.S. Morsi, (2009); Improved Properties of Incorporated Chitosan Film with Ethyl Cellulose Microspheres for Controlled Release. *Int. J. Pharm*., 375, 67–74.
16. A.J. Desmarais and R.F. Wint, (1983); *Chapter 19 - Hydroxyalkyl and ethyl of cellulose, Polysaccharides and their Derivatives, Industrial Gums (Third Edition)*, 505-535, https://doi.org/10.1016/B978-0-08-092654-4.50023-1
17. E. Erdem, M. Saçak and M. Karakisla, (1996); Synthesis and Properties of Oxalic Acid-doped Polyaniline, *Polymer International*, 39, 2, 153–159. DOI:10.1002/(SICI)1097-0126(199602)39:2<153::AID-PI481>3.0.CO;2-E
18. S. Jadhava, D. Jaspalb and V.V. Chabukswar, (2014); Synthesis and characterization of conducting poly N-ethyl aniline doped with organic acids, *Journal of Chemical and Pharmaceutical Research*, 6, 10, 44-49.
19. Gandhimathi, R.T. Karunakaran, A. Elakkinakumaran, S. Prabahar and R. Sathyalakshmi, (2020); Growth and Characterization Studies of an Organic Nonlinear Optical Crystal - Oxalic Acid Dihydrate, *International Journal of Scientific Research in Physics and Applied Sciences*, 8, 3, 54-59. https://doi.org/10.26438/ijsrpas/v8i3. 54 5 9
20. V. Sangawar and C.S. Adgaonkar, Indian Journal of Pure and Applied Physics, 33, 401-11, (1995).
21. N.G. Belsare and V.S. Deogaokar, (1998); Electrical conductivity of iodine doped polyblend films of polystyrene (PS) and polymethyl methacrylate (PMMA); *Indian Journal of Pure and Applied Physics*, 36, 280-89.
22. N.G. Belsare and V.S. Deogaokar, (1998); TSDC study of iodine doped polyblends of Polystyrene (PS) and Polymethyl-methacrylate (PMMA), *Journal of Polymer Materials (Oxford and IBM Pub.Co.Pvt.Ltd.)*, 15, 157-70.
23. R. Bahri and B.R. Sood, (1983); Effect of iodine doping on the photoconductivity of polystyrene thin films, *Thin Solid*, 100, 1, L5-L8 https://doi.org/10.1016/0040-6090(83)90232-8

24. V. Suthar, A. Pratap and H. Raval, (2000); Studies on poly(hydroxyl alkanoates)/(ethylcellulose)blends; *Bull. Mater. Sci.,* 23, 3, 215–219. https://doi.org/10.1007/bf02719913
25. K.K. Khichar, S.B. Dangi, V. Dhayal, U. Kumar, S.Z. Hashmi, V. Sadhu, B. Lal Choudhary, S. Kumar and S. Kaya, (2020); Structural, optical, and surface morphological studies of ethyl cellulose/graphene oxide nanocomposites, *Polymer composites*, 41, 7, 2792-2802, https://doi.org/10.1002/pc.25576
26. M. Pandey, G.M. Joshi, A. Mukherjee and P. Thomas, (2016); Electrical properties and thermal degradation of poly(vinyl chloride)/polyvinylidene fluoride/ZnO polymer nanocomposites, *Polymer International*. https://www.researchgate.net/publication/304022401
27. Bushra A. Hasan, Ahmad A.Hasan and Duaa-A-Umran, International Journal of Application or Innovation in Engineering & Management,2,11,86, (2013).
28. S. Rajendran, R. Kannan and O. Mahendran, (2001); Ionic conductivity studies in poly(methylmethacrylate)–polyethlene oxide hybrid polymer electrolytes with lithium salts, *Journal of Power Sources*, 96, 2, 406-410. https://doi.org/10.1016/s0378-7753(00)00573-5
29. S. Rajendran and T. Uma, (2000); Conductivity studies on PVC/PMMA polymer blend electrolyte, *Materials Letters*, 44, 3-4, 242-247. https://doi.org/10.1016/s0167-577x(00)00036-7
30. M.K. Trivedi, A. Branton, D. Trivedi, H. Shettigar and K. Bairwa, (2015); Fourier Transform Infrared and Ultraviolet-Visible Spectroscopic Characterization of Biofield Treated Salicylic Acid and Sparfloxacin, *Natural Products Chemistry & Research*, 03, 05, 186. https://doi.org/10.4172/2329-6836.1000186
31. X.H. Guan, G.H. Chen and C. Shang, (2007); ATR-FTIR and XPS study on the structure of complexes formed upon the adsorption of simple organic acids on aluminum hydroxide, *J Environ Sci (China)*, 19, 4, 438-443. https://doi.org/10.1016/s1001-0742(07)60073-4