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Effect of Doping Ratio on FTIR Spectrum of Coumarin Doped Polystyrene films

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Abstract

Fourier transform infrared (FTIR) spectroscopy is one of the powerful tools for identifying and investigating the presence of various functional groups in polymers. We studied the transmission FTIR spectra of coumarin laser dye, polystyrene polymer, and coumarin doped polystyrene films with different doping ratio of coumarin solution. All samples prepared by casting method. Increasing doping ratio of coumarin solution will clear the role of coumarin laser dye on FTIR spectrum by appearing peaks refers to dye which have evaluated and compared with other researches..

KeyWord: FTIR Spectrum, Coumarin, Polystyrene Polymer, Effect of Doping Ratio, Dye Doped Polymer Films.

1. Introduction

The laser dye that acts an active medium in dye laser, either; it is in solution case when dissolve in an appropriate solvent, or it is in solid state when doping with polymer material; so that the physical properties of these dyes must studied very well. Dye lasers utilizing a solid material are very attractive for a wide range of applications including selective photothermolysis in medicine, remote sensing of atmospheric contaminants underwater, communication and optoelectronic field[Costela et al, 1998]. Polystyrene (PS) is a type of polymer with thermoplastic properties, colorless and rigid plastic. It is used to produced many products for industrial [Al-Ghamdi and Mahrous,(2011); Alwaan, (2012)].

In infrared spectroscopy, IR radiation is passed through a sample. Some of the radiation is absorbed by the sample and some of it is passed through it (transmitted). The resulting spectrum represents the molecular absorption and transmission creating molecular fingerprint of the sample. Each molecule distinguishes by certain FTIR spectrum refers to it. No two unique molecular structures produce the same infrared spectrum. This makes the infrared spectroscopy useful for several types of analysis [Thermo, (2001); Silverstein and Webster, (2004)].

Many researchers have synthesized and tested a lot of chemical substances, which have proved to be a very good laser dye, the dye has however to be embedded in host polymer. So, the spectroscopic characteristics and kinetic of dye must be studied[Crompton (2009); Abd Elmongy, (2009)]. The incorporation of coumarin in host PS polymer will obviously induce structural changes. So that, in this paper the structural properties of Coumarin doped polystyrene PS polymer films are studied by FTIR method. Also, the effect of variation of the doping ratio of coumarin dye solution will be studied.

2. Experimental Work

Coumarin laser dye has been selected supplied from Lambda physics, and used without further purification. The chemical formula of coumarin is ($C_9H_6O_2$), and molecular weight (146.15)g/mole. The chemical structure of coumarin laser dye is shown in fig.(1)[wisegeek].Polystyrene PS polymer supplied from ICI Company. The chemical structure of PS polymer is shown in fig.(2)[wikipidealinking; Mitchell, (2004)].

Coumarin doped PS polymer films were fabricated by casting method**[**Mani Vannua, (1994)**]**. The solution of the polymer is prepared by dissolving the required amount of polymer (0.5 g) in (10 ml) of solvent Chloroform. The dye solution prepared as the method mentioned in reference**[**AL-Kadhemy et al, (2011)**]** was 1×10^{-4}mol\liter. In every case, we change the doping ratio of coumarin dye solution that added to the polymer solution and stirred very well to get a uniform mixture. The selected doping ratio of dye solution are (10, 20, 30, 40, 50, and 60) ml. This mixture poured into glass Petri dish with (10 cm) diameter, and leave to dry under normal laboratory conditions (darkroom, room temperature) for 24hr to get homogeneous dye doped polymer films.

FTIR spectrum has been carried out using (FTIR-84005 Fourier Infrared spectrophotometer

SHIMADZU).

3. Results and Discussions

The FTIR spectra of coumarin laser dye, pure PS polymer, and coumarin doped PS films are taken in the frequency range (4000-400) cm^{-1} in transmission mode.

3.1 Coumarin Laser Dye

Fig. (3) shows the FTIR spectrum of coumarin laser dye and compared with chemical formula of this dye. There were more than one peak obtained in region of the C–H bending vibrations out of plane (900-600) cm^{-1}can support the presence of an aromatic structure. In region (1200-1000) cm^{-1}, there is a peak at 1028.09 cm^{-1} refers to C–H bending vibrations in of plane[Kaniappan1 and Latha, (2011)], The benzene rings very clear which is supportive to the peak at 1489.10 cm^{-1} that acts the C=C stretching (1400-1600) cm^{-1}. of the benzene ring, and a peak at 3061.13 cm^{-1} for C–H stretching (3000-3100) cm^{-1} [Silverstein et al, (1981)].

3.2 Pure Polystyrene Polymer Film

Fig (4) give the characteristics of FTIR spectra of pure PS polymer , Many bands refer to the ring deformation vibration are observed at 702.11 cm^{-1}. Also, the C-H deformation vibration band of benzene ring hydrogen's is appeared at 758 cm^{-1}. The two peaks at 1583.61 cm^{-1} and 1600.97 cm^{-1} are assigned to aromatic C = C stretching. While, the two bands at 2850.88cm $^{-1}$ and2931.90 cm^{-1} are corresponding to aromatic and aliphatic C-H stretching, respectively. The C-H stretching vibration of ring hydrogen's is assigned to 3101 cm^{-1}. These results agree with mentioned by [Abaas , (2013)] and similar to the studies of [Kaniappan and Latha,(2011), and M.F. Al-Kadhemy et al, (2013)]**.**

3.3 Coumarin - PS films

Figs. (5) and (6) represent the FTIR spectra of Coumarin doped PS polymer with different doping ratio (10, 20, 30, 40, 50, and 60) ml, respectively. There is clear change in spectrum, so that we can conclude that Coumarin affect on PS polymer; the spectral data system of the polymer PS and C-PS films involved are listed in Table (1) The real importance of (FTIR) spectroscopy is to identify the main characteristics peaks of Coumarin dye, PS and demonstrate the effect of addition of C dye on these polymers. The band at (667.39 cm^{-1}) refer to C-H out of phase bending is disappeared for all doping ratio, the new band at(943.22 cm^{-1}) appearance from doping 30ml to 60 ml. The band at (979.87 cm^{-1}) refer to C-O stretch and (1583.61 cm^{-1}) refer to C=C stretch are disappearance for all doping ratios. , the last band is shifted to (1541.18 cm^{-1}) in doping ratio 10 ml. The band at (3005.20 cm^{-1}) refer to C-H stretching of aromatic group is disappearance for all different doping ratio.

4. Conclusion

The effect of amount of doping ratio of coumarin laser dye that added to coumarin doped polystyrene films on FTIR spectrum were studied. It was found that increasing doping ratio of coumarin led to appear some peaks refer to dye which means that the structure of C-PS films will changeable.

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www.wikipidealinkiing.com, coumarin.

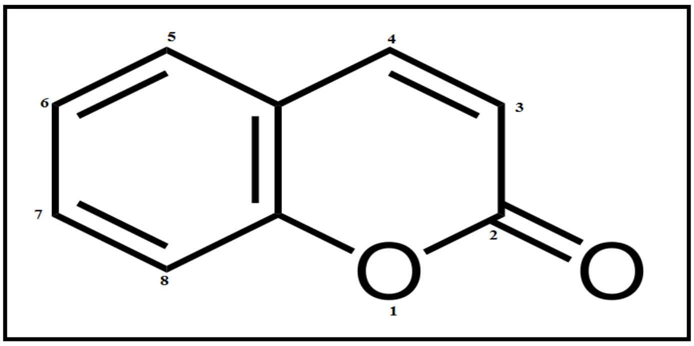

Fig.(1) The chemical structure and numbering scheme of Coumarin [wisegeek].

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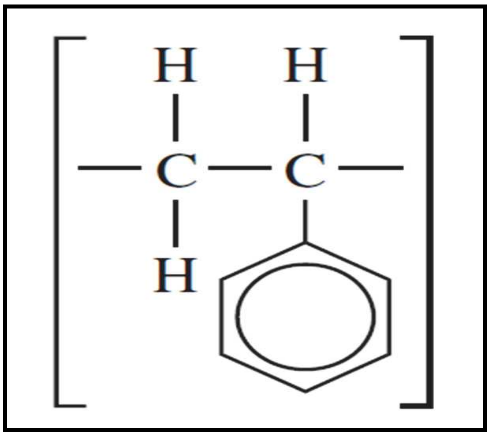

Fig.(2)Chemical structure of PS [Mitchell, (2004)].

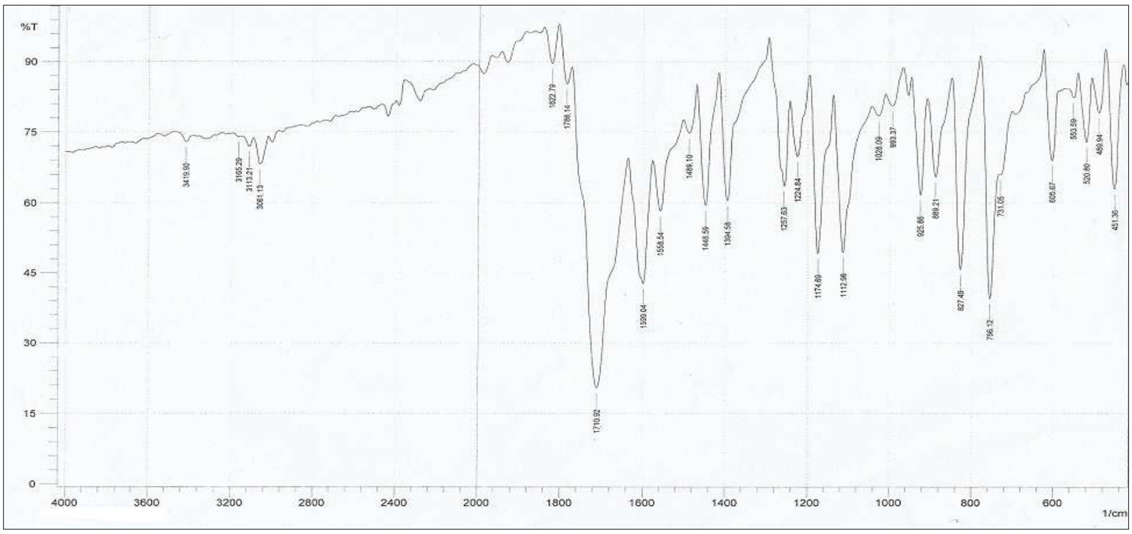

Fig.(3) FTIR spectrum for Coumarin laser dye

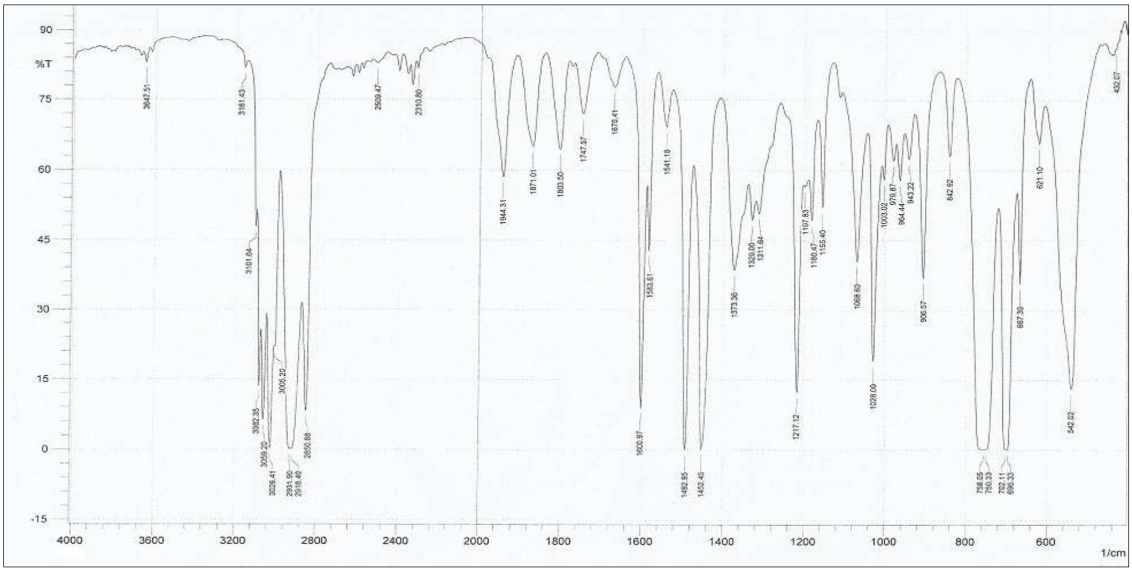

Fig. (4) FTIR spectrum for PS polymer

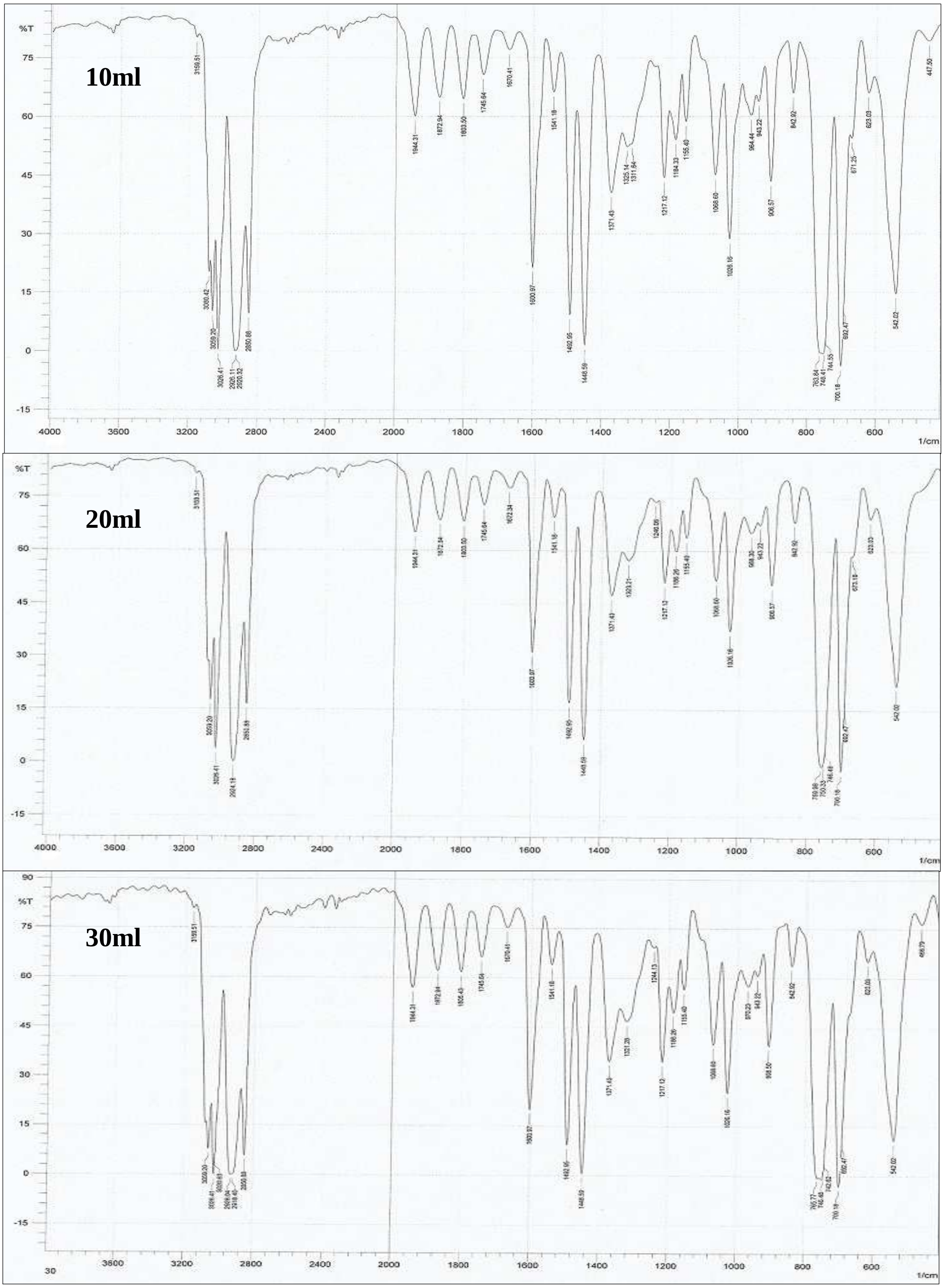

Fig. (4) FTIR spectrum for Coumarin doped Polystyrene film by

10 ml,20ml,30ml.

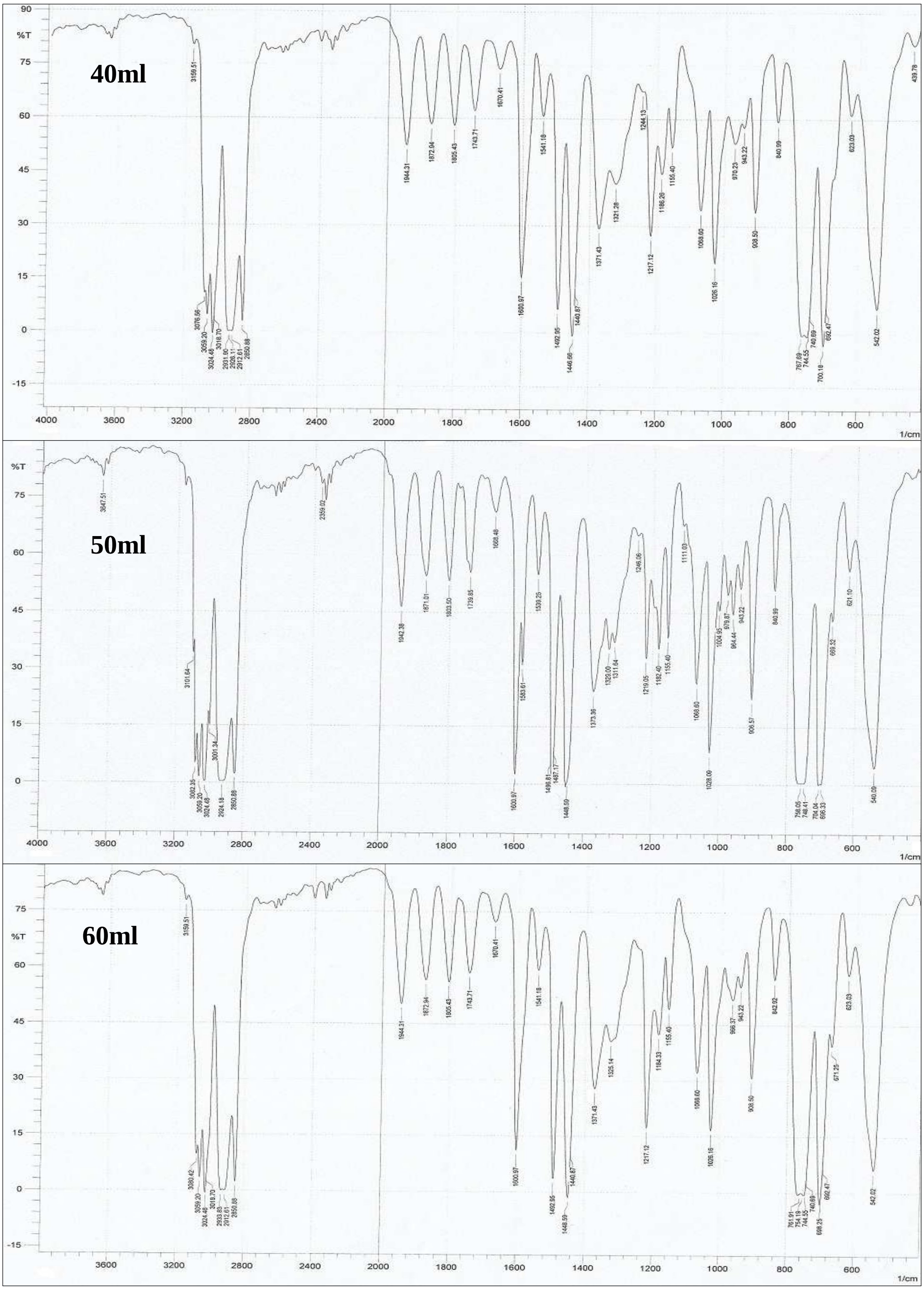

Fig. (5) FTIR spectrum for Coumarin doped Polystyrene film by

Table (1) The val

40 ml,50ml,60ml.

C-PS films with different doping ratio	Pure PS	10 ml	20 ml	30 ml	40 ml	50 ml	60 ml
C-H out phase bend (625-970)cm^{-1}	667.39 696.33 702.11 750.33 758.05 842.92 906.57	671.25 692.47 700.18 744.55 748.41 763.84 842.92 906.57	673.18 692.47 700.18 746.48 750.33 759.98 842.92 906.57 943.22 968.30	692.47 700.18 742.62 746.48 765.77 842.92 908.50 943.22	692.47 700.18 740.69 744.55 767.69 840.99 908.50 943.22	673.18 692.47 698.25 740.69 744.55 767.69 840.99 908.50 943.22	**694.40 704.04 750.33 840.99 906.57 943.22 964.44**
C-O stretch (880-1000) cm^{-1}	906.57 943.22 964.44 979.87	906.57 943.22 964.44	906.57 943.22 968.30	908.50 943.22	908.50 943.22	908.50 943.22 968.30	
CH_2 bending (1300-1380) cm^{-1}	1311.64 1329.00 1373.36	1311.64 1325.14 1371.43	1323.21 1371.43	1321.28 1371.43	1321.28 1371.43	1321.28 1371.43	**1311.64 1373.36**
CH_2 wagging C=C stretch (1550-1610) cm^{-1}	1583.61 1600.97	1541.18 1600.97	1600.97	1600.97	1600.97	1600.97	**1583.61**
C=O (1550-1750) cm^{-1}	1583.61 1600.97 1670.41 1747.57	1600.97 1670.41 1747.64	1600.97 1672.34 1745.64	1600.97 1670.41 1745.64	1600.97 1670.41 1743.71	1600.97 1670.41 1743.71	**1668.48 1739.85**
C-H stretch Aliphatic (2800-3000) cm^{-1}	2850.88 2918.40 2931.90	2850.88 2920.32 2926.11 2931.90	2850.88 2920.32	2850.88 2918.40 2928.04	2850.88 2912.61 2926.11 2931.90	2850.88 2916.47 2929.97	**2850 2920.32**
C-H stretch Aromatic (2800-3060) cm^{-1}	2850.88 2918.40 2931.90 3005.20 3026.41 3059.20	2850.88 2920.32 2926.11 2931.90 3059.20	2850.88 2920.32 3026.41 3059.20 3159.51	2850.88 2918.40 2928.04 3020.63 3026.41 3059.20	2850.88 2912.61 2926.11 2931.90 3018.70 3024.48 3059.20 3076.56 3159.51	2850.88 2916.47 2929.97 3020.63 3026.41 3059.20	**2850 2920.32 3024.48 3082.35**
H hydroxyl (3440-3600) cm^{-1}	3647.51	3647.51	3647.51	3647.51	3647.51	3647.51	**3647.51**