ISSN : 2249 - 8877 Volume 3 Issue 3

Trade Science Inc.

Research & Reviews On Polymer

Full Paper

RRPL, 3(3), 2012 [102-106]

FTIR spectrum of laser dye fluorescein doped polymer PMMA films

Mahasin F.Hadi AL-Kadhemy*, Eman Mohi Alwaan

AL-Mustansiriyah Univ., College of Science , Physics Dept., Baghdad, (IRAQ)

E-mail : drmahasinf@yahoo.com; emanmohi20@yahoo.com

ABSTRACT

We present the absorption of FTIR spectrum of pure polymethylmethacrylate polymer with different weight, pure laser dye fluorescein, and fluorescein dye doped PMMA polymer films with different doping ratio of fluorescein solution. All these films are prepared by casting method. It was found that the effect of increased doping ratio of fluorescein solution on FTIR spectrum led to increased the two distinct band (2989.66, 2951.61)cm^{-1} and decreased other bands. The role of added fluorescein dye clear at peaks (1635, 1581) cm^{-1} which corresponds to conjugated keton which increased with increased doping ratio. Also, the effect of carboxylic acid salt was shown at peaks (1481.33, 1448.61, 1388.75) cm^{-1} with increased the dye solution added to polymer. The effect of decreased weight of PMMA polymer led to increased the intensity of the peaks that appeared in FTIR spectrum. This study is to determine the effect of change the weight of polymer and doping ratio of dye solution on FTIR spectrum, which have been evaluated and compared with other researches.

KEYWORDS

FTIR spectrum;
Dye doped polymer films;
Laser dye;
Fluorescein.

INTRODUCTION

The heart of any dye laser is the laser dye that acts an active medium in it. Either; it is in solution case when dissolve in an appropriate solvent, or it is in solid state when doping with polymer material. Laser dye plays an important role in defining the physical properties of dye laser. 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 under water, communication and optoelectronic field[1].

The xanthene dye molecules have been used in many scientific and technological applications like fluorescein dye used for laser system, solar energy accumulator, holographic according immunoassay analysis and others[2-4].

Among the polymer properties as low as cost, high processability, light transparency, chemical and thermal stabilities. Also, polymers are interesting media for solid state dye laser, non-linear optical devices, optical computing and selective chemical reactions[5,6]. Many research groups have synthesized and tested a numerous chemical substances, which have proved to be a good laser dye, the dye has however to be embedded in host polymer. So, the spectroscopic properties and kinetic of dye must be studied[7,8].

The incorporation of fluorescein in host polymer will obviously induce structural changes. So that, in this paper the structural properties of fluorescein doped poly (methyl methacrylate) PMMA polymer films are studied by FTIR method. Also, the effect of variation of weight of polymer and the doping ratio of fluorescein dye solution will be studied.

EXPERIMENTAL WORK

Fluorescein laser dye has been selected supplied from Lambda physics, and used without further purification. The chemical formula of fluorescein is ($C_{20}H_{12}O_5$), and molecular weight (332.31)gm/mole. The chemical structure of fluorescein laser dye is shown in figure 1[9].

Poly (methyl methacrylate) PMMA polymer supplied from ICI Company. The chemical structure of PMMA polymer is shown in figure 2[10].

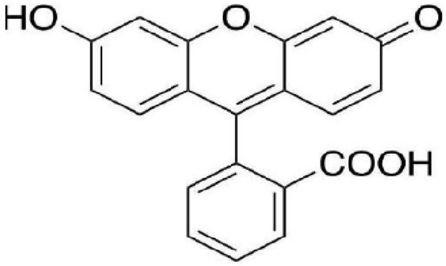

Figure 1 : Chemical structure of fluorescein laser dye[9]

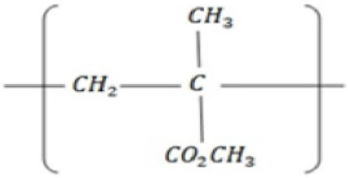

Figure 2 : Chemical structure of PMMA polymer[10]

Fluorescein doped PMMA polymer films were fabricated by casting method[11]. The solution of the polymer is prepared by dissolving the required amount of polymer (0.4 and 0.5 gm) in (10 ml) of solvent Acetone.

The dye solution prepared as the method mentioned in reference[12] was 10^{-2}mol\liter. In every case, we change the doping ratio of fluorescein dye solution that added to the polymer solution and stirred very well to get a uniform mixture. This mixture poured into glass Petri dish with (10 cm) diameter, and leave to dry under normal laboratory conditions (dark room, room temperature) for 24hr to get homogeneous dye doped polymer films.

The samples that studied in our work are arranged and numbered according to the weight of polymer and the value of doping ratio of dye solution, as shown in TABLE 1.

TABLE 1 : The arrangement of samples

No. of samples	Weight of polymer (gm)	Doping ratio of fluorescein solution (ml)
1	0.5	0
2	0.5	2
3	0.5	4
4	0.5	8
5	0.5	12
6	0.4	0
7	0.4	1
8	0.4	5
9	0.4	10

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

RESULTS AND DISCUSSIONS

The FTIR spectrum of pure PMMA with weight (0.5gm soluble in 10ml acetone), sample 1, in the frequency range (4000-400) cm^{-1} is shown in figure 3, in absorption mode.

This spectrum is comparable to earlier reports[10,13,14]. Two bands appeared at 2989.66 $cm^{-1}$and 2951.09 $cm^{-1}$with intensity (1.3, 1.4), respectively. The first band arises from the methyne C-H stretch, and the second band arises from the asymmetrical (as) stretching mode in which two C-H bonds of the methyl group are extending.

There is two distinct bands 1735.93 cm^{-1} and 1728.22 cm^{-1} which are very strong with intensity (3.7,3.6), respectively. The structure of pure PMMA is characterized by 1735.9cm^{-1} band which assigned to free lateral C=O stretching as shown by Tomar et al[15] and Laska[16]. The other band 1728.22 cm^{-1} refers to esters (C-O-C) groups[16]. The peak 1481.33$cm^{-1}$with intensity (1.2) corresponds to methylene C-H bends (CH_2 scissoring)[13-17]. The other peak 1448.61cm^{-1}(intensity 1.4) attributed to CH_3 asymmetric stretching or deformation of PMMA[18].

The characteristic peak at 1388.75 cm^{-1}, (intensity 0.9) is appeared due to O-CH_3 deformation of PMMA[17]. The absorption bands corresponding to skeletal C-C vibrations are appeared at 700-1300 cm^{-1}as demonstrated by Coates[13].

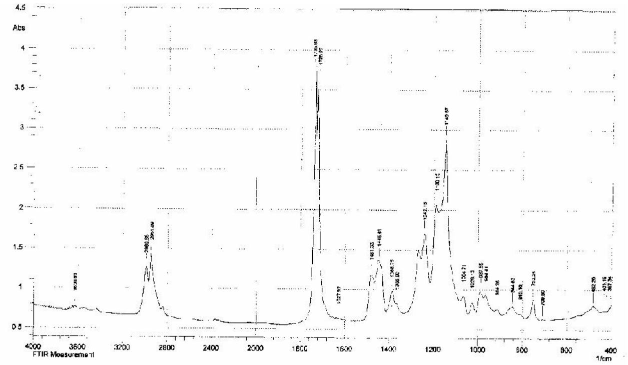

Figure 3 : FTIR spectrum for (0.5gm) PMMA polymer (sample 1)

For pure fluorescein, the FTIR spectrum is shown in figure 4, in absorption mode. There is wide band from (3570-3200) cm^{-1}corresponding to hydroxyl group, H-bonded-OH stretch, and narrow band (3645-3600) cm^{-1} attributed to non-bonded hydroxyl group, OH stretch as demonstrated by Coates[13].

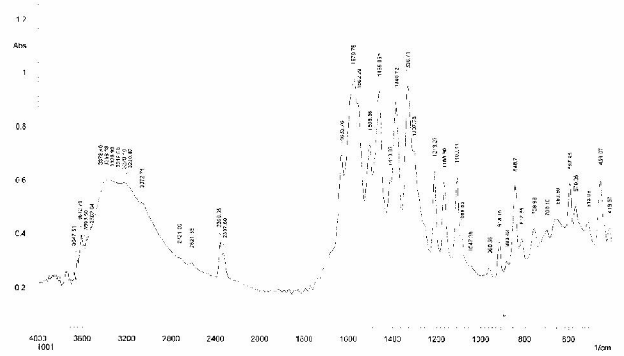

Figure 4 : FTIR spectrum for pure fluorescein

The bands from (1420-1300) cm^{-1} refer to carboxylic acid salt. The other most important set of bands are aromatic ring vibrations centered around 1600 cm^{-1} and 1500 cm^{-1}, which usually appeared as a pair of band structures, often with some splitting. Then the aromatic C-H out of plane bend clear at (900-670) cm^{-1} and O-H out of plane bend clear at (700-590) cm^{-1}[13].

The FTIR spectra of fluorescein doped PMMA films for different doping ratio of fluorescein solution (with sample no.(2,3,4,5)), as shown in TABLE 1 are demonstrated in figures (5-8), respectively.

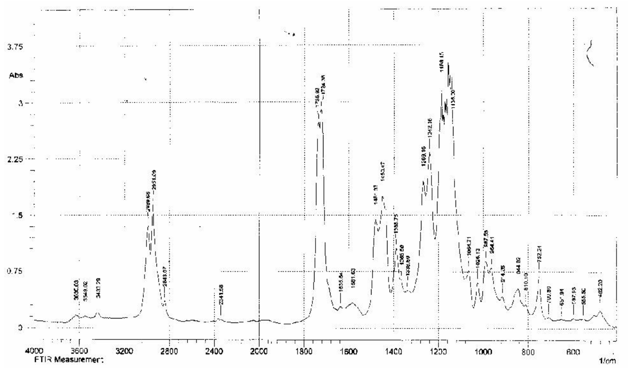

Figure 5 : FTIR spectrum for (0.5gm) PMMA polymer doped (2ml) fluorescein solution (sample 2)

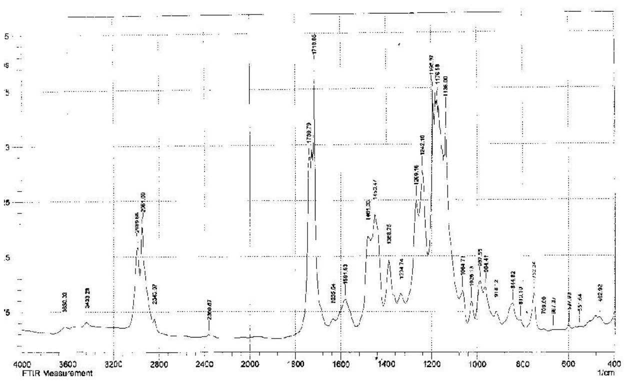

Figure 6 : FTIR spectrum for (0.5gm) PMMA polymer doped (4ml) fluorescein solution (sample 3)

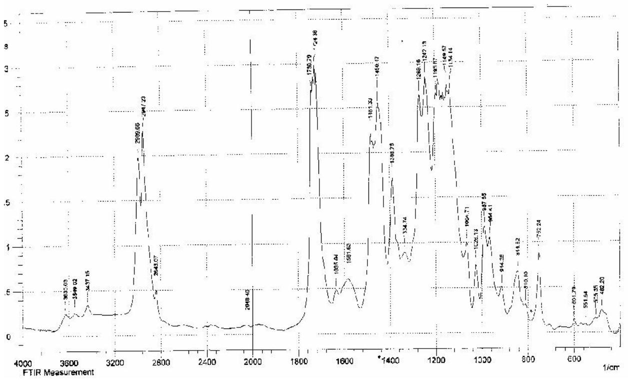

Figure 7 : FTIR spectrum for (0.5gm) PMMA polymer doped (8ml) fluorescein solution (sample 4)

The intensity of two bands (2989.66, 2951.09) cm^{-1} increased with increasing the doping ratio of fluorescein solution. The intensity of band 1739.93 cm^{-1}will decreased with increasing doping ratio until damaged with the second band 1724.36 cm^{-1}at sample (5) to be one peak.

There are some peaks (1635,1581) cm^{-1}will appeared in samples (2-5). The first band corresponds to conjugated keton that is lower frequency band which is from conjugated double band that found in fluorescein dye. The second band refers to carboxylate form, these two peaks clearly show the effect of fluorescein solution as demonstrated in figure 4. Whereas the three peaks (1481.33, 1448.61, and 1388.75)cm^{-1} increased with increasing the doping ratio. This shows the effect of carboxylic acid salt from fluorescein solution.

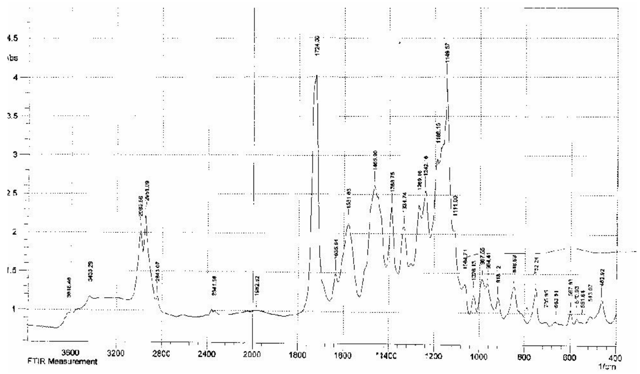

Figure 8 : FTIR spectrum for (0.5gm) PMMA polymer doped (12ml) fluorescein solution (sample 5)

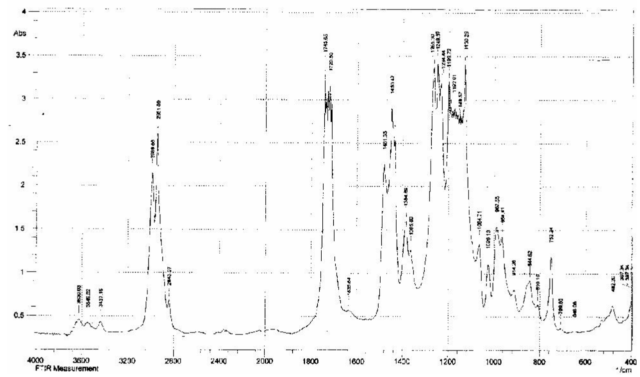

Figure 9 : FTIR spectrum for (0.4gm) PMMA polymer (sample 6)

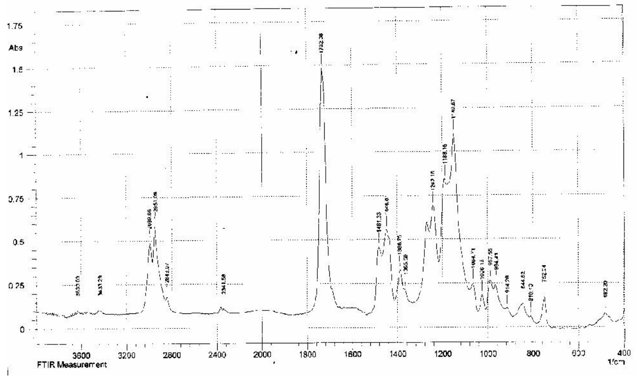

Figure 10 : FTIR spectrum for (0.4gm) PMMA polymer doped (1ml) fluorescein solution (sample 7)

The C-O stretch was observed obviously within range (1070-1140)cm^{-1}with increasing doping ratio of fluorescein solution, and other peaks (1195.87, 1149.5, 1134.14, and 1064.71) cm^{-1} will appeared due to effect of fluorescein dye.

When the weight of PMMA polymer decreased to be (0.4gm); sample (6) in TABLE 1, the FTIR spectrum is shown in figure 9 in absorption mode. The two distinct peaks (2898 and 2951)cm^{-1} were obviously clear and higher intensity than it in figure 3. The bands (1743.65, 1720.50) cm^{-1}corresponds to C-O-C ester and carbolic acid, respectively. Decreasing concentration of PMMA polymer led to increase the intensity of all peaks (1600-400) cm^{-1}.

FTIR spectra for samples (7-9) are shown in figures (10-12), which take the same behavior with samples (2-5).

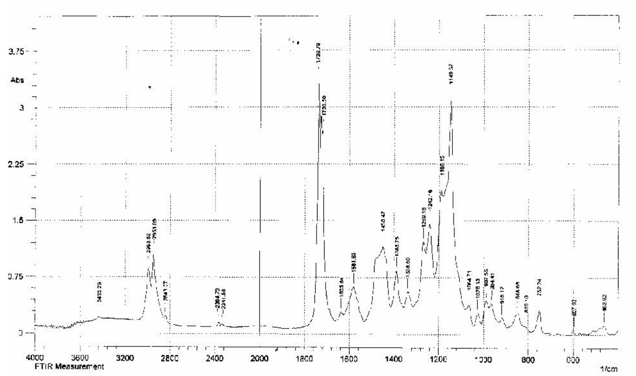

Figure 11 : FTIR spectrum for (0.4gm) PMMA polymer doped (5ml) fluorescein solution (sample 8)

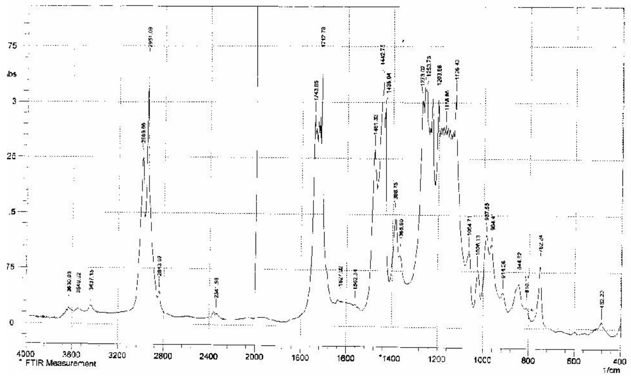

Figure 12 : FTIR spectrum for (0.4gm) PMMA polymer doped (10ml) fluorescein solution (sample 9)

CONCLUSION

The effect of change of weight of polymer (PMMA), and the amount of doping ratio of fluorescein solution that added to polymer- dye mixture on FTIR spectrum were studied. Decreasing weight of PMMA polymer doesn't change the behavior of spectrum, only increase the intensity of peaks. Whereas increasing the doping ratio of dye solution led to disappear some peaks and demonstrate other peaks that confirm the role of fluorescein dye on FTIR spectrum.

REFERENCES

[1] A.Costella, I.Garcia-Moreno, J.M.Figuera, A.F. Amat-Guerri, R.Sastre; Laser Chem., **18**, 63-84 **(1998)**.
[2] R.Sjoback, J.Nygren, M.Kubista; Spectrochimica Acta, part A51, L7-L21 **(1995)**.
[3] F.P.Schäfer; Dye laser, Springer-Verlage, Berlin, **(1990)**.
[4] M.F.AL-Kadhemy, A.A.AL-Zuky I.F.AL-Sharuee; International J.of Mat.Phys., **2(1)**, 75-86 **(2011)**.
[5] P.Kumar Dubey, R.Bajpai, J.M.keller; Microsyst. Technol., **14**, 1165–1171 **(2008)**.
[6] A.F.Mansour, M.G.El-shaarawy, S.M.El-Bashir, M.K.El-Mans, M.Hammam; Ploym.Int., **51**, 393–397 **(2002)**.
[7] T.R.Crompton; Characterization of Polymers, Smithers Rapra, **2**, **(2009)**.
[8] S.Abd Elmongy; Australian J.Basic and Appl.Sci., **3(3)**, 1954–1963 **(2009)**.
[9] M.F.AL-kadhemy; Atti Della, Fondazione Giorgio Ronchi, **2**, 217–224 **(2011)**.
[10] M.Rosemul, H.Mas Haris, S.Kathiresan, S.Mohan; Scholars Research Library, Der Pharmachemica, **2(4)**, 316–323 **(2010)**.
[11] G.Mani Vannua, P.Ledere, S.Senial, R.Charnkui, Y.Renotte, Y.Lion, R.A.Lessard; Appl.Phys., **B58**, 73 **(1994)**.
[12] M.F.AL-Kadhemy, I.F.AL-Sharuee, A.A.Dawood AL-Zuky; Malaysian J.Phys.Sci., **22(2)**, 77-86 **(2011)**.
[13] J.Coates; In Encyclopedia of Analytical Chemistry, R.A.Meyers, (Ed); John Wiley & Sons Ltd, Chichester, 10815–10837 **(2000)**.
[14] V.Sankar, T.Suresh Kumar, K.Panduranga Rao; Trends Biomater.Artif.Organs., **17(2)**, 24–30 **(2004)**.
[15] A.K.Tomar, S.Mahendia, Sh.Kumar; Pelagia research library, Advances in Appl.Sci.Res., **2(3)**, 327–333 **(2011)**.
[16] J.Laska; J.Mol.Struc., **13**, 701 **(2004)**.
[17] K.Kaniappan, S.Latha; International J.Chem.Tech.Research, **3(2)**, 708–717 **(2011)**.
[18] M.S.Khan, R.A.Qazi, M.S.Wahid; African J.Pure and Appl., **2(4)**, 041–045 **(2008)**.