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XRD and FTIR studies for Ag/PMMA Nano composite thin films

A.Kadhim, Hammad R. Humud, and Lubna Abd Al Kareem

Abstract*— Ag/PMMA nanocomposite thin movies stored on glass substrates by in-situ airborne helped plasma jet polymerization at climatic weight and room temperature from MMA monomer within the sight of Ag nanoparticles were considered. Five different concentration of silver nanoparticles were used (3, 5, 7, 9 and 11wt%).The prepared thin films were characterized by XRD, FT-IR, the results indicate that the synthesized polymer and their Ag nanocomposites are expected to be good candidates for applications in optical devices like optical switches and optical limiting.

***Index Terms*— Ag/PMMA nanocomposite , XRD , FT-IR**

I. INTRODUCTION

Nobel metal nanoparticles exhibit new physical-chemical properties which are not watched either in individual atoms or in mass metals. Their unique optical, electrical and magnetic properties depend on the shape and size of the nanoparticles. Among these nanometals, silver nanoparticles are particularly important due to their high electrical and thermal conductivities and strong absorption of electromagnetic waves in the visible range [1,2]. Nanocomposites are another class of materials in which the measurement of one of the scattered particles happened at the nanometer scale, accordingly in polymer-metal nanocomposites, metal particles are scattered in the polymer grid at the nanometer scale [3,4]. Noble metal nanoparticle/organic polymer composite films are of particular interest because of their potential applications for photonics and electro optics. Polymer matrices can anticipate oxidation and blend of the particles and give them with a long-time stability. As a result, the specific optical and electrical properties of the nanoparticles can be brought into full play, while the typical advantages of organic polymers (e.g., transparency, elasticity, relatively simple ways of synthesis, etc.) are retained in the composite films [5,6]. several techniques have been proposed for the manufacture of nanocomposite films containing honorable metal nanoparticles scattered in polymer template such as chemical method, in situ reduction method, physical vapor deposition (PVD), Electrochemical technique [7, 8]. Finally, plasma polymerization as do in this work which is the deposition by combination of atmospheric plasma and aerosol.

Retrofit bundles [2]. Single-fuel vehicles streamlined for packed characteristic gas are prone to be impressively more appealing as far as execution and to some degree more alluring as far as expense. As per Chaichan [5] that a characteristic gas-controlled, single-fuel vehicle ought to be fit for comparative force, comparable or higher effectiveness and for the most part lower discharges than an equal petrol-fueled vehicle. Such a vehicle would have a much shorter driving extent unless the fuel tanks are made expansive, which would then involve a further punishment in weight, space, execution and expense. CNG vehicles' extent constraints, be that as it may, would be facilitated impressively if LNG were substituted as the fuel [13]. The CNG fuel properties and characteristics are given in Table 1.

Packed Natural Gas (CNG) is appealing for five reasons. It is the main fuel less expensive than gas or diesel [18]. It has characteristically brought down air contamination emanations [2]. It has lower nursery gas emanations [9]. Its utilization broadens petroleum supplies and there are vast amounts of the fuel accessible on the planet [12].

II. EXPERIMENTAL PROCEDURE

A. Samples preparation:

Silver PMMA nanocomposite thin films were set up by dielectric obstruction release plasma stream, the movies were saved on glass substrates. The glass substrates have standard sizes of 10 x 10 mm. Cleaning process was carried out by using acetone under ultrasonic condition prior to the plasma polymerization. Monomer (MMA) have been used. Argon gas passes across the nobilizer which contains a mixture of silver nanoparticles and MMA, the mixture converts to aerosol, this aerosol was guided by the gon gas to the plasma jet, the plasma was ignited by using an electric source at a fixed frequency of (28 KHz). The plasma was generated downstream to the substrate which was positioned along fixed distance from the plasma torch end which was (1.5cm). The film deposition time was 5min. and the substrate moved on the x and y direction mechanically to obtaining a homogeneous films thickness along the substrate area.

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B. X-Ray Diffraction:

In order to study the constitutional properties, the structure is resolve with a MINIFLEX II X-ray diffractometer regulation, Japan which enrollment the intensity as a function of Bragg's angle. The source of radiation is (Cu- kα) with wavelength λ =1.5406Å, current of 30mA and voltage of 40 kV. The survey angle is varied in the range of 0 – 100 degree.

C. FT-IR analysis:

The FT-IR spectrum introduce information about the molecules present in the Specimen. FT-IR type 8000 series Fourier transformation (Shimadzu Co., Japan) was used to record Fourier transformation of infrared spectra by utilizing KBr plates and examine infrared spectrophotometer at wavenumber range of 400–4000 cm^{-1} under identical conditions.

III. Results and Discussion

Figures 1, 2 and 3 show the XRD pattern of the prepared PMMA thin film and Ag/PMMA nanocomposite films at silver NPs concentration 7wt% and 11 wt%, . From Figure 1 it seems clear that Pure PMMA thin film possesses no crystalline structure therefore, we can say that amorphous structure. Figures 2 and 3 represent the XRD pattern structure Ag/PMMA nanocomposite and it shows that all the peaks the interview of metals pure silver with cubic structure. And refraction provided by the five main peaksat 2θ = 38.160, 44.320, 64.440, 77.420 and 81.540◦which are assigned to the lattice planes (1 1 1), (2 0 0), (2 2 0), (3 1 1) and (2 2 2) this behavior agrees with references [9, 10].

Figures 4 – 9 shows the FT-IR spectra for pure PMMA and Ag/PMMA nanocomposite thin films at different Ag NPs concentrations which were prepared at the same conditions. The FT-IR absorption bands for pure PMMA and Ag/PMMA nanocomposite thin films are given in table 1 .The FT-IR range of PMMA demonstrates the subtle elements of utilitarian gatherings presents in the manufacturing PMMA and these results agree with [11, 12] .It can also see a shift in C=O ester carbonyl group, C=C, CH3, C-C for the Ag/PMMA nanocomposite thin films this indicates that the silver nanoparticles modify the PMMA thin films structure.

IV. Conclusions

The preparation of nanocomposite films by plasma polymerization leads to fabricate a new material with different chemical structure.

The plasma polymer different from conventional polymer that it has high cross linked, highly branched and high density.

References

[1] M. Torres-Cisneros, N. Yanagihara, B. Gonzalez-Rolon, M.A. Meneses-Nava, O.G. Ibarra-Manzano, D.A. May-Arrioja, J. Sa´nchez-Mondrago´n, E. Aguilera-Go´mez, L.A. Aguilera- Corte´s, " Synthesis and nonlinear optical behavior of Ag nanoparticles in PMMA", Microelectronics Journal, vol.40, pp.621-623, (2009).

[2]M. Ghanipour, D. Dorranian, "Effect of Ag-Nanoparticles doped in Polyvinyl Alcohol on the structural and optical properties of PVA films", Journal of Nanomaterials, vol.2013, pp.1-10, (2013).

[3] O. M. Folarin1, E. R. Sadiku, A. Maity, "Polymer-noble metal nanocomposites: Review", International Journal of the Physical Sciences, vol. 6(21), pp. 4869-4882, (2011).

[4] Emad Yousif 1, Ahmed A. Al-Amiery 2,3,*, Abdulhadi Kadihum 4, Abdul Amir H. Kadhum 3 and Abu Bakar Mohamad 3,5 , Photostabilizing Efficiency of PVC in the Presence of
Schiff Bases as Photostabilizers" Molecules 2015, 20, 19886–19899; doi:10.3390

[5] Hammad R. Humud†*, Abdulhadi Kadhim† and Lubna Abd Al Kareem" Gas Flow Rate Effect on the Nonlinear Optical Properties of Ag/Pmma Nanocomposite Thin Films Prepared by Aerosol Assisted Dielectric Barrier Discharge Plasma Jet Polymerization" International Journal of Current Engineering and Technology, Vol.5, No.5 (Oct 2015)

[6] R. Zeng, M. Rong, " Interfacial interaction in Ag/polymer nanocomposite films", journal of materials science letters, vol. 20, pp. 1473 – 1476, (2001).

[7]M. Ghanipour, D. Dorranian, "Effect of Ag-Nanoparticles doped in Polyvinyl Alcohol on the structural and optical properties of PVA films", Journal of Nanomaterials, vol.2013, pp.1-10, (2013).

[8] W.M. Shakier, A. Kadhim*, A.Z. Mohammed "Corrosion Inhibitor for St-37 Alloy by Laser Shock Peening Technique" Journal of Advanced Electrochemistry 2(1) (2016) 56–59

[9]N. Singho, M. Johan, N. CheLah, " Temperature-dependent properties of silver-poly (methylmethacrylate) nanocomposites synthesized by in-situ technique", Nanoscale Research Letters, vol.9, pp.1-6, (2014).

[10] N. Faraji, W. Yunus, A. Kharazmi, E. Saion, " Third-order nonlinear optical properties of silver nanoparticles mediated by chitosan", optic, vol.125, pp.1-4, (2014).

[11] T. P. Kasih, " Development of novel potential of plasma polymerization techniques for surface modification", Gunma University, Ph.D Thesis, (2007).

[12] M. Haris, S. Kathiresan, S. Mohan, " FT-IR and FT-Raman Spectra and Normal Coordinate Analysis of Poly methylmethacrylate", Der Pharma Chemica, vol.2, pp. 316-323, (2010).

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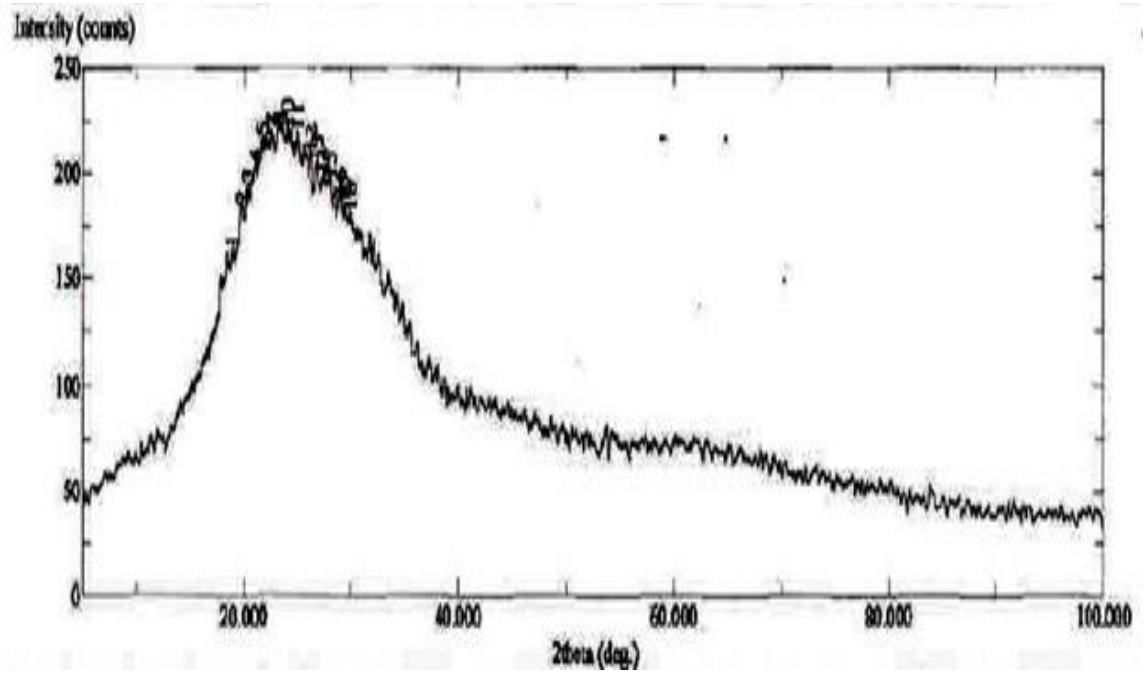

Fig. 1: XRD for PMMA thin film.

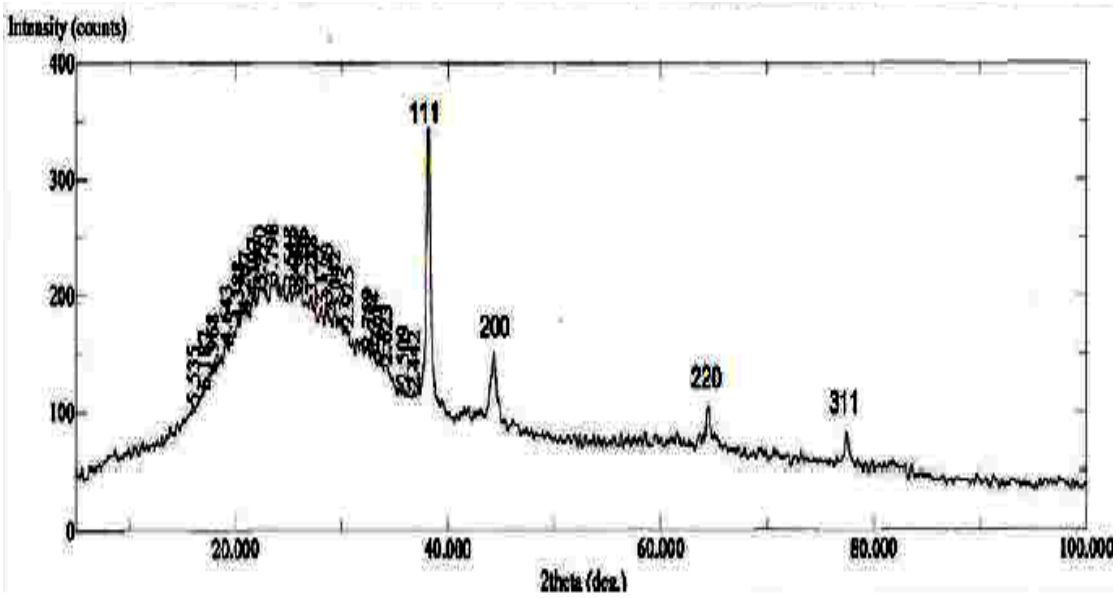

Fig. 2: XRD pattern for Ag/PMMA nanocomposite film at 7wt

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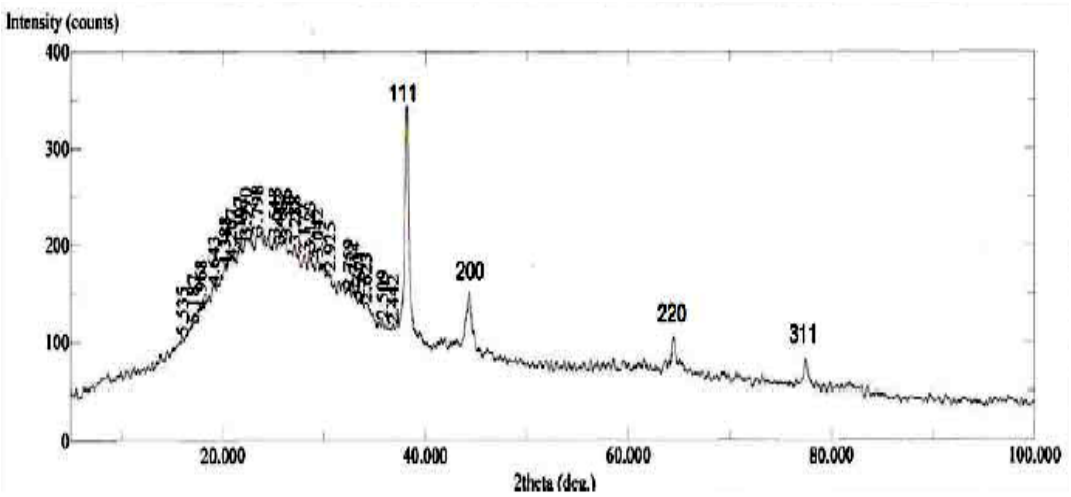

Fig. 3: XRD pattern for Ag/PMMA nanocomposite film at 11wt %

Table 1: FT-IR absorption bands for PMMA and Ag/PMMA nanocomposite thin films

Bond range(cm-1)	**P1**	**AgP4**	**AgP5**	**AgP6**	**AgP9**	**AgP10**	**Expected vibration**
2850-2950	2854.45 2925.81	2894.95	2896.88 2977.89	---	2991.39	2842.88 2981.74	C-H
(1720-1740)	1745.46	1741.60	1741.60	1739.67	---	1739.67	C=O ester carbonyl group stretching vibration
Around 1630	1650.95	1652.88	1647.10 1693.38	1647.10	1647.10	1643.24	C=C
(1395-1450)	1460.01	1396.37 1456.16	---	1396.37 1450.37	1461.94	1396.37 1461.94	CH3
Around 1388	1382.87	1367.44 1338.51	1365.51	---	---	1367.44	O-CH3
(1150-1250)	116.85	---	---	---	---	1228.57	C-O-C stretching of ester group
(1050-1300)	114.78 1166.85	1070.42	1070.42	---	---	1078.13	C-O
(700-1300)	1000.99	744.47 952.77 1018.34	937.34	750 1072.35	---	927.70 854.41	C-C
		690.47 676.97 570.89 453.24 420.45	692.40 555.46 449.38 414.67	694.33 568.96 507.24 449.38 418.52	690.47 449.38 420.45	692.40 570.89 449.38	Ag

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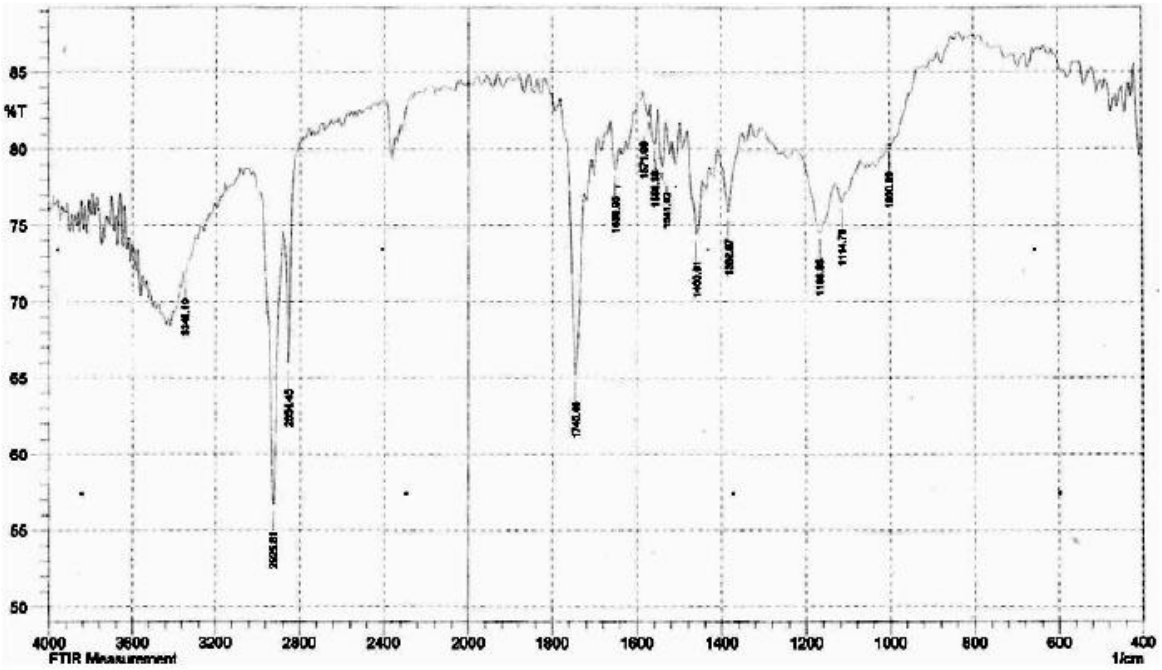

Fig. 4: FT-IR spectrum for pure PMMA

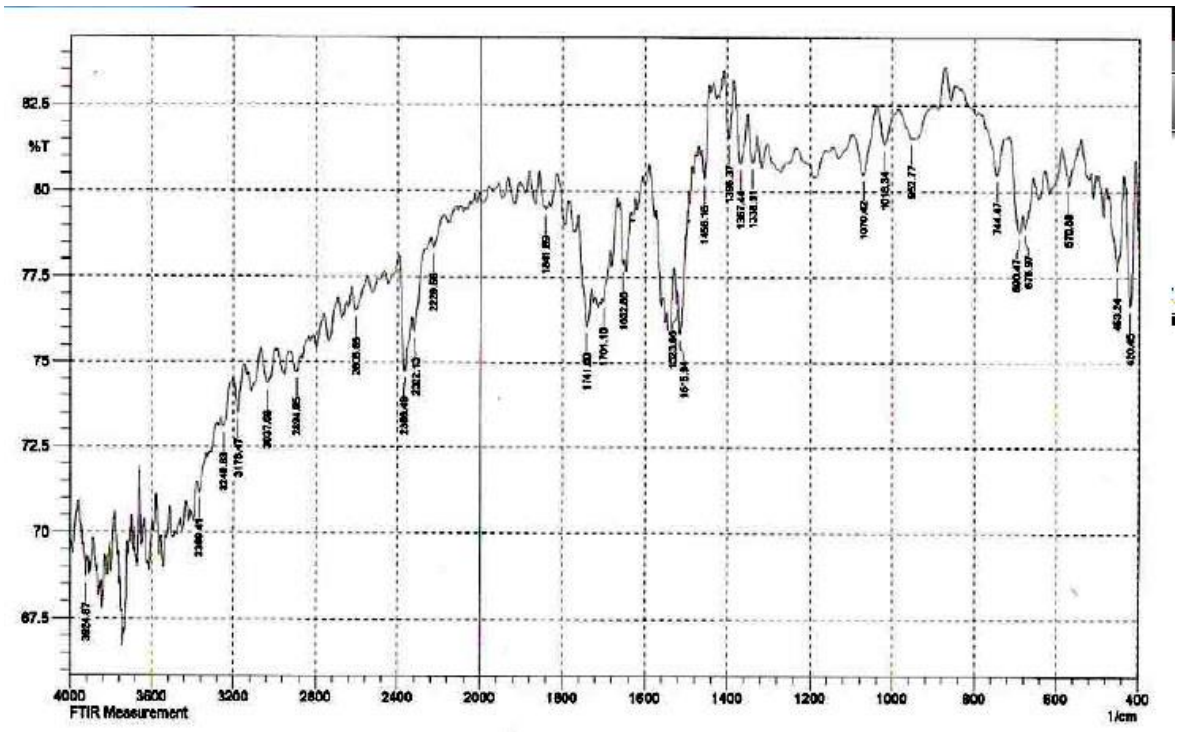

Fig. 5: FT-IR spectrum for Ag/PMMA nanocomposite with 3wt% silver NPs

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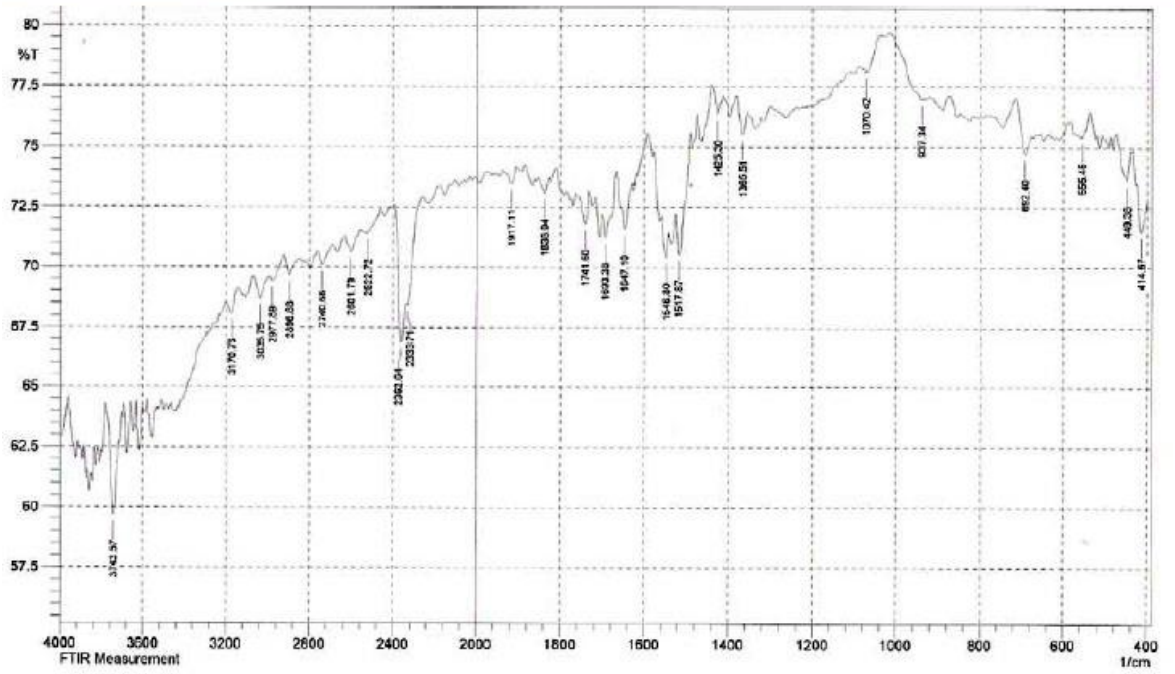

Fig. 6: FT-IR spectrum for Ag/PMMA nanocomposite with 5wt% silver NPs

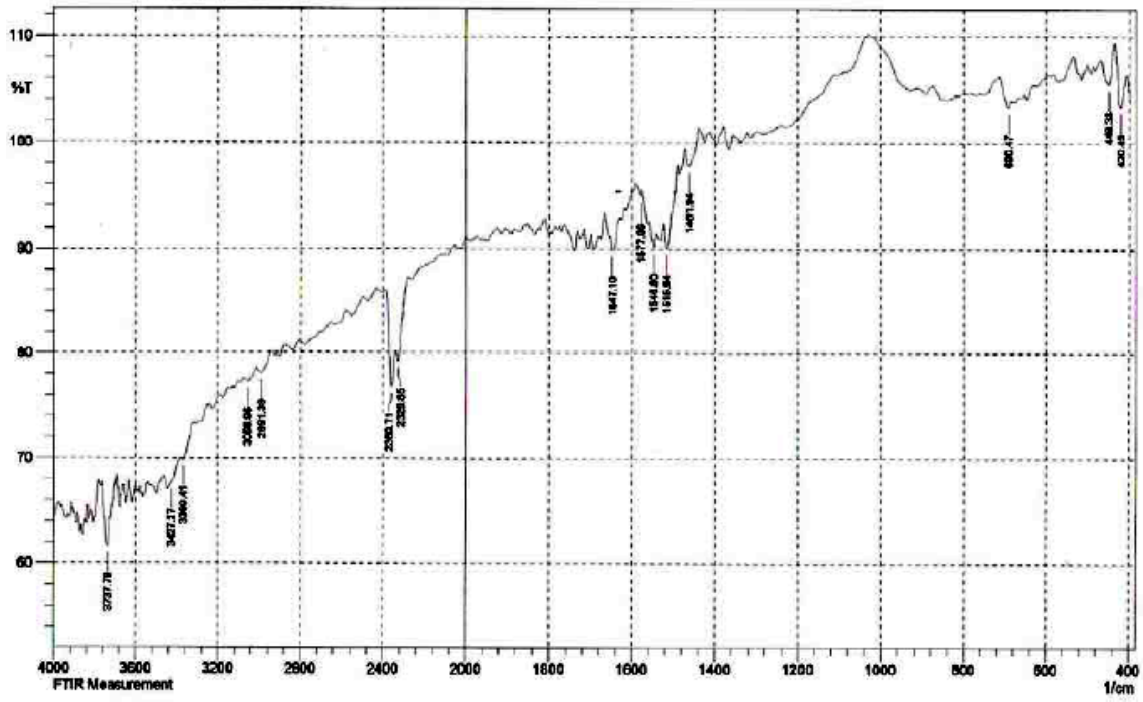

Fig. 7: FT-IR spectrum for Ag/PMMA nanocomposite with 7wt% silver NPs

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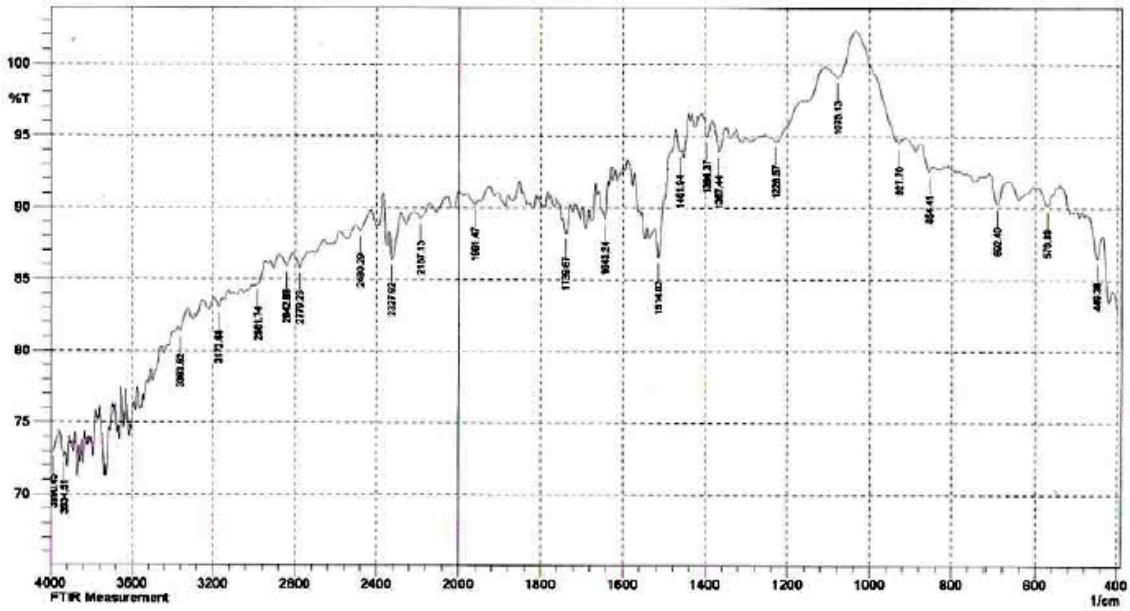

Fig. 8: FT-IR spectrum for Ag/PMMA nanocomposite with 9wt% silver NPs

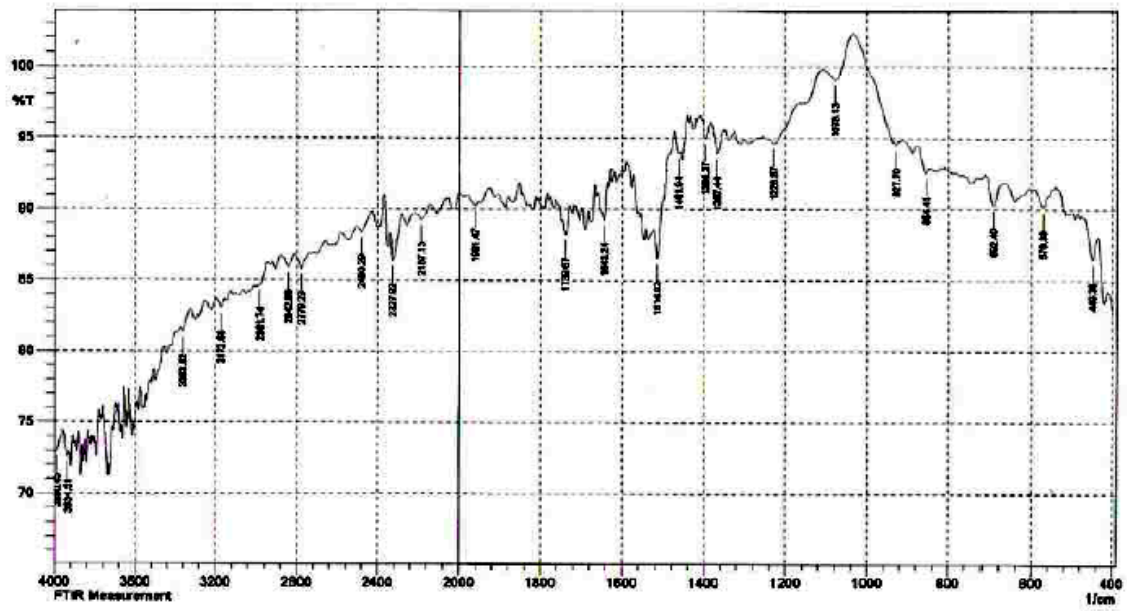

Fig. 9: FT-IR spectrum for Ag/PMMA nanocomposite with 11wt% silver NPs