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# Preparation of Thermally Stable Acrylic Polymers

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ABSTRACT. Monomers of N-phenyl methacrylamide (PPM), N-(p-methyl phenyl) methacrylamide (PMPM) and N-(p-methoxy phenyl) methacrylamide (PMOM) were prepared and the optimum conditions for their polymerization were investigated by following the polymerization time, effect of ratio of initiator, as well as the effect of solvent.

The polymers obtained were characterized by determining the viscosity number, Infrared spectroscopy, elemental analysis, metal analysis, and thermo-gravimetric analysis (TGA).

Micro-analytical data and IR-spectra of PPM, PMPM, and PMOM confirmed the structures of the prepared polymers. According to IR-spectra and micro-analytical data, the structures for the polymer complexes are suggested.

Thermo-analytical results of PPM, PMPM, and PMOM and their polymer complexes showed two to three stages of decomposition.

## Introduction

Polymers provide one of the most versatile groups of materials and find widespread use as plastics, rubbers, fibers, adhesives and coatings. The advantages of these materials, especially their ease of fabrication and low density, for use in an ever widening range of products have become more appreciated by designers and engineers. However, some inherent deficiencies in these materials have prevented their employment in certain areas of application. Polymers show extreme sensitivity to temperature. Most importantly, owing to the intrinsic flexibility of their molecular chains, they exhibit very low softening points. Polymers will have high softening points if they have a high glass transition temperature ($T_g$) and/or melting temperature ($T_m$).

A further restriction to their use at high temperature is their susceptibility to atmospheric oxidation when used at elevated temperature. This oxidation usually leads to polymer chain scission by way of a free radical chain reaction. Many common polymers oxidize at appreciable rates at temperatures as low as 100°C, so long term use at these temperatures or above can lead to premature product failure. The susceptibility of a polymer to thermal oxidation is largely dependent on the strengths of the C-H bonds from which hydrogen atoms are abstracted by the propagating free radicals[1].

The bond forming cross-links in network polymers contribute significantly to thermal stability. They are dimensionally stable under a wide variety of conditions due to their rigid network structure[2-4]. Polymer metal complexes are synthesized by reaction of a polymer containing donating groups such as amine, heterocyclic nitrogen, carboxylic acid, ketone, phosphonic acid, or thiol with metal ion. The reaction of polymer ligand with metal ion usually results in various coordination structures, which are divided chiefly into pendant and inter-, and/or intramolecular bridged complexes[5].

The chelating ligand groups show excellent ability to adsorb metal ions selectively[6-9]. The polymer metal complex is insoluble in water or in organic solvents. It is usually difficult to distinguish between the inter- and intramolecular bridging[10-26].

James *et al.*[27] reported that the glass transition temperature ($T_g$) has been increased on complexation of poly (tetramethylglycol) and poly (propylene oxide) with $ZnCl_2$. A satisfactory model for the poly (propylene oxide) complexes has been postulated involving coordination of two adjacent ether oxygen atoms in the polymer backbone to the metal salt, thus creating five-membered rings.

The activation energies of the thermal degradation of the polymer complexes[28-32] were calculated using Arrhenius relationship and were found to be in the range (3.5 - 3.6) kJ/mol.

## Experimental

### *Materials*

Methacryloyl chloride, copper (II) acetate dihydrate, copper (II) chloride, p-anisidine, and p-toluidine were used as received without further purification (all from Aldrich); aniline, dimethyl formamide, petroleum ether (60-80°C), and tetrahydrofuran (all from BDH), were used without further purification. Benzene (BDH) was distilled and kept over sodium metal. 2,2-azobisiso-butyronitrile (AIBN) (Flnka) was recrystallized from ethanol.

### *Methods*

**I-** ***Preparation of N-phenyl methacrylamide, N-(p-methyl phenyl) methaeryl-amide and N-(p-methoxy phenyl) methaerylamide***

The monomers were prepared by the addition of equimolar amounts of methacryloyl chloride to a stirred solntion of aniline, p-toluidine or p-anisidine in DMF as a solvent in an ice bath. The reaction mixtures were precipitated by pouring into a large excess of distilled water in an ice bath. The monomers were filtered, washed with distilled water and dried under vacuum.

**II-** ***The optimum conditions for polymerization of N-phenyl methacrylamide were investigated as follows***

**1-** ***Time of polymerization :*** The bomopolymer was prepared by boiling under reflux N-phenyl metbacrylamide (0.5 g) in DMF (2 ml) as a solvent, and in the presence of 0.05 g (10% w/w) AIBN as initiator for different times.

**2-** ***Effect of ratio of initiator :*** 0.5 g of the monomer was boiled under reflux with 2 ml DMF as solvent and different ratios of AIBN as initiator for 5 hours.

**3-** ***Effect of solvent :*** The homopolymer was prepared by boiling the monomer (0.5 g) under reflux with 0.05 g (10% w/w) AIBN as initiator in the presence of different solvents (Benzene, DMF, or THF) for five hours.

### III- *Preparation of poly N-(p-methyl phenyl) methacrylamide and poly N-(p-methoxy phenyl) methacrylamide*

A solution of the monomer (4.9 g) in dry benzene (20 ml) with AIBN (0.2 g) as initiator was boiled under reflux for five hours. The reaction mixture was precipitated by pouring into a large excess of petroleum ether (60-80°C) and kept in the freezer for 10 days.

The precipitated polymers were filtered and dried under vacuum for several days.

### IV- *Preparation of the polymer metal complexes*

Polymer complexes of poly-(N-phenyl) methacrylamide (PPM), poly N-(p-methyl phenyl) methacrylamide (PMPM) or poly N-(p-methoxy phenyl) methacrylamide (PMOM), with copper (II) acetate and copper (II) chloride were prepared by free radical polymerization. Equimolecular amounts of monomers and metal salts were dissolved in DMF. The reaction mixture was boiled under reflux for 6 hr. The resulting solution was added to cold water acidified with HCl, and the formed polymer complex was precipitated, filtered and dried under vacuum.

### V- *Characterization of the polymers*

**1-** ***Determination of the viscosity number :*** A dry sample (0.05 g) was dissolved in DMF and its viscosity was measured at 25°C.

**2-** ***Infrared spectroscopy :*** IR spectra were recorded using Perkin-Elmer infrared spectrophotometer.

**3-** ***Elemental Analysis :*** (Carbon, hydrogen and nitrogen content were performed for monomers, and polymers).

**4-** ***Metal analysis :*** The metal analysis were carried out using Perkin-Elmar atomic absorption.

### VI- *Thermogravimetric analysis (TGA)*

TGA measurements were recorded with Perkin-Elmar, TGA 7, thermal analysis system. Samples were heated from 30°C to 700°C in a platinum pan with a heating rate 20°C/min., in air 25 ml/min.

## Results and Discussion

Table 1, shows the effect of time of polymerization on the viscosity and yield of poly (N-phenyl methacrylamide) (ppm). The maximum yield and viscosity were obtained at 5 hrs polymerization time.

Table 1. Effect of time of polymerization on the viscosity and yield of poly (N-phenyl methacrylamide) (ppm).

| Time (hr) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Yield (g) | 0.28 | 0.3 | 0.31 | 0.32 | 0.34 | 0.39 | 0.28 |
| reduced viscosity | 0.19 | 0.23 | 0.49 | 0.57 | 0.7 | 0.65 | 0.55 |

Table 2, shows the effect of solvents on the yield and viscosity of PPM. The results revealed that the maximum yield and viscosity were obtained using benzene as a solvent.

Table 2. Effect of solvents on the yield and viscosity of PPM.

| Solvent | DMF | BENZENE | THF |
|---|---|---|---|
| Yield (g) | 0.34 | 0.40 | 0.2 |
| reduced viscosity | 0.7 | 0.88 | 0.5 |

Table 3, shows the effect of ratio of AIBN on the polymerization of PPM. The optimum ratio of AIBN was (5% w/w).

Table 3. Effect of ratio of AIBN on the polymerization of PPM.

| Ratio of AIBN (% w/w) | 2.5% | 5% | 10% | 15% |
|---|---|---|---|---|
| Yield (g) | 0.30 | 0.36 | 0.34 | 0.31 |
| reduced viscosity | 0.68 | 0.79 | 0.7 | 0.68 |

It was concluded, from Tables 1-3, that the optimum conditions for polymerization of PPM were as follows:

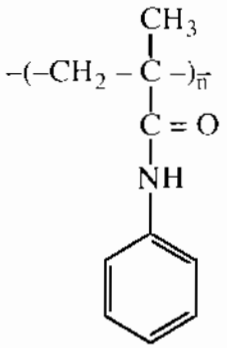
Time of polymerization is 5 hr. solvent used is benzene, and ratio of initiator is 5% (w/w).

Table 4, shows the micro-analytical data for the prepared polymers.

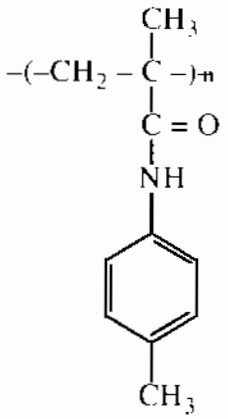
Table 4. Micro-analytical data for the prepared polymers.

| Compound | Analysis (%)Found/(calculated) | | |
|---|---|---|---|
| | % C | % H | % N |
| poly(N-phenyl)methacrylamide (PPM) | 73.82 (74.49) | 6.73 (6.8) | 8.21 (8.69) |
| poly [N-(p-methyl phenyl) methacrylamide (PMPM) | 74.51 (75.38) | 7.18 (7.48) | 7.62 (8.0) |
| poly N-(p-methoxy phenyl) methacrylamide (PMOM) | 68.84 (69.07) | 6.54 (6.86) | 7.18 (7.33) |

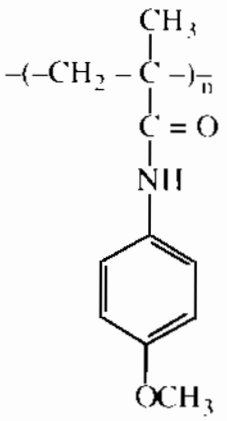
The micro-analytical data confirmed the following structures of the prepared polymers :



(PPM)



(PMPM)



(PMOM)

IR spectrum of PPM (Fig. 1-3), PMPM (Fig. 4-6), and PMOM (Fig. 7-9) confirmed the structures of the prepared polymers. The band characteristic of amide I band ν (C=O) appeared at (1665 - 1650) $cm^{-1}$. The bands at (1600 - 1590) $cm^{-1}$, (1510 - 1490) $cm^{-1}$ are characteristic of benzene ring. The band at (1380 - 1370) $cm^{-1}$ was attributed to CH symm. def. of $CH_3$. The amide II band ν (C–N) + δ (N–H) showed a band in the range (1560 - 1525) $cm^{-1}$. Also a band at (1340 - 1310) $cm^{-1}$ was due to amide III band δ (C–N).

Table 5. IR bands assignment for PPM.

| Band | Assignment | Band | Assignment |
|---|---|---|---|
| 3210 | ν (N–H) | 2930, 2870 | ν (C–H) |
| 1665 | Amide I band ν (C = O) | 1600 | Benzene ring |
| 1560 | Amide II band ν (C=N) + δ (N–H) | 1510, 1450 | Benzene ring |
| 1375 | C–H symm. deform. of $CH_3$ | 1320 | Amide III band δ ( C–N) |
| 910, 860 | δ (C–H) bending | | |

Table 6. IR bands assignment for PMPM.

| Band | Assignment | Band | Assignment |
|---|---|---|---|
| 3290 (s) | ν (OH) free | 3070 | ν (N–H) |
| 2930, 2860 | ν (C–H) | 1660 | Amide I band n (C = O) |
| 1545 | Amide II band ν (C=N) + δ (N–H) | 1590 | Benzene ring |
| 1490, 1460 | Benzene ring | 1310 | Amide III band δ ( C–N) |
| 1370 | C–H symm. deform. Of $CH_3$ | 900, 860 | δ (C–H) bending |

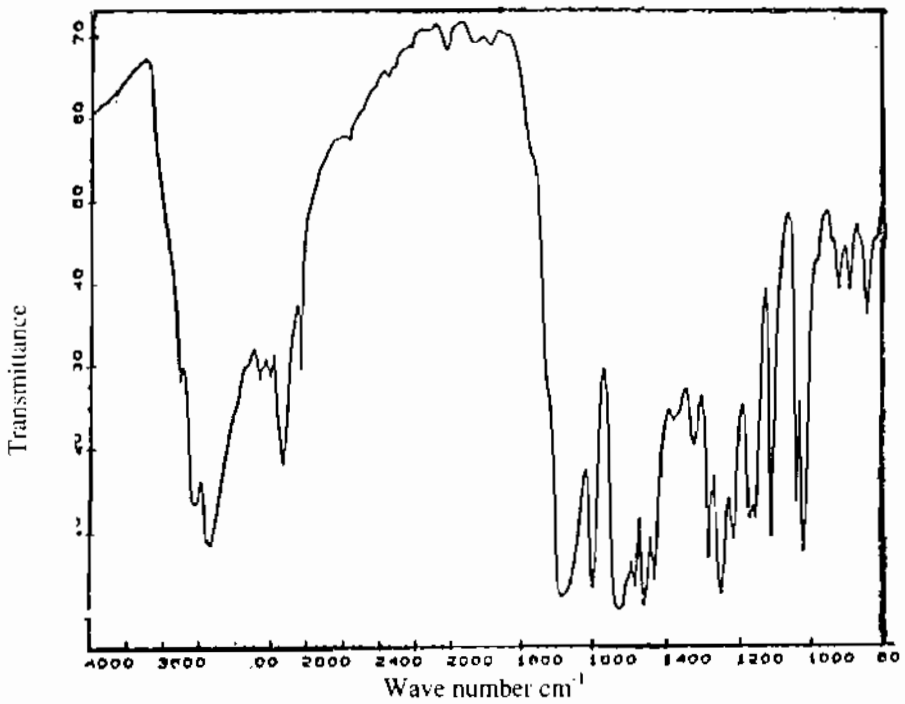



Fig. 1. IR spectrum of PPM.

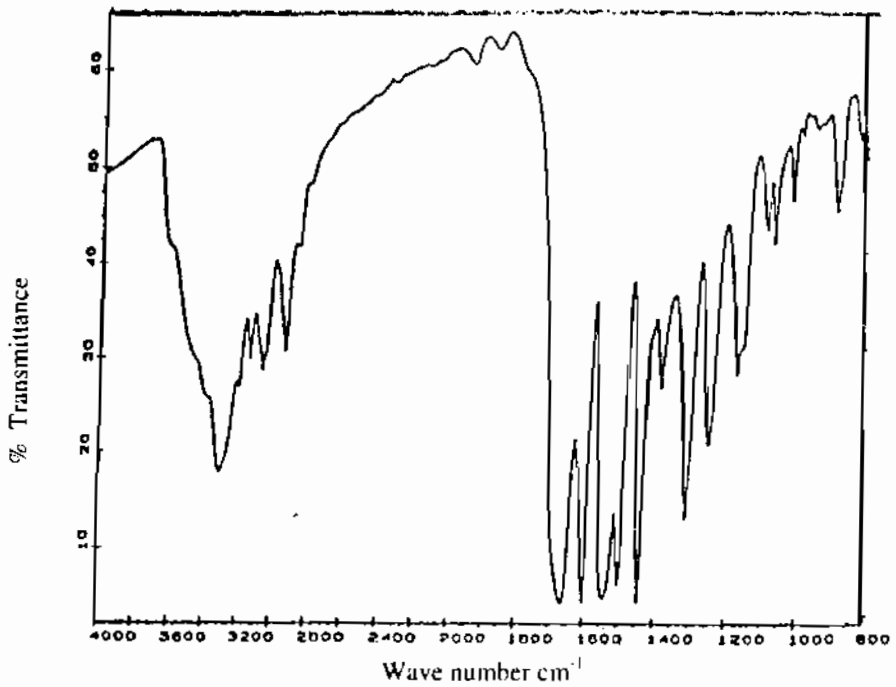



Fig. 2. IR spectrum of PPM-Copper acetate.

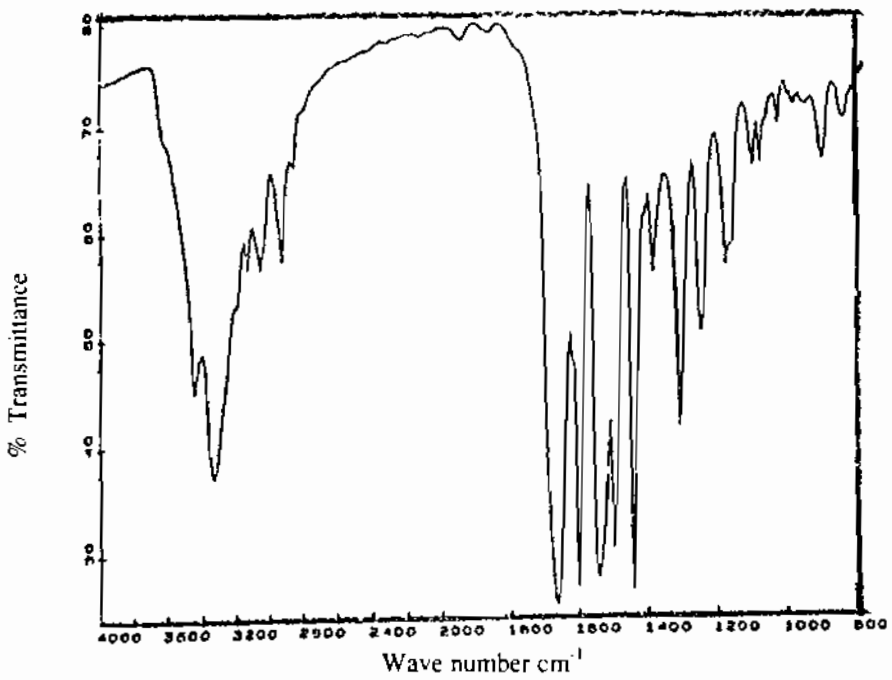



Fig. 3. IR spectrum of PPM-Copper chloride.

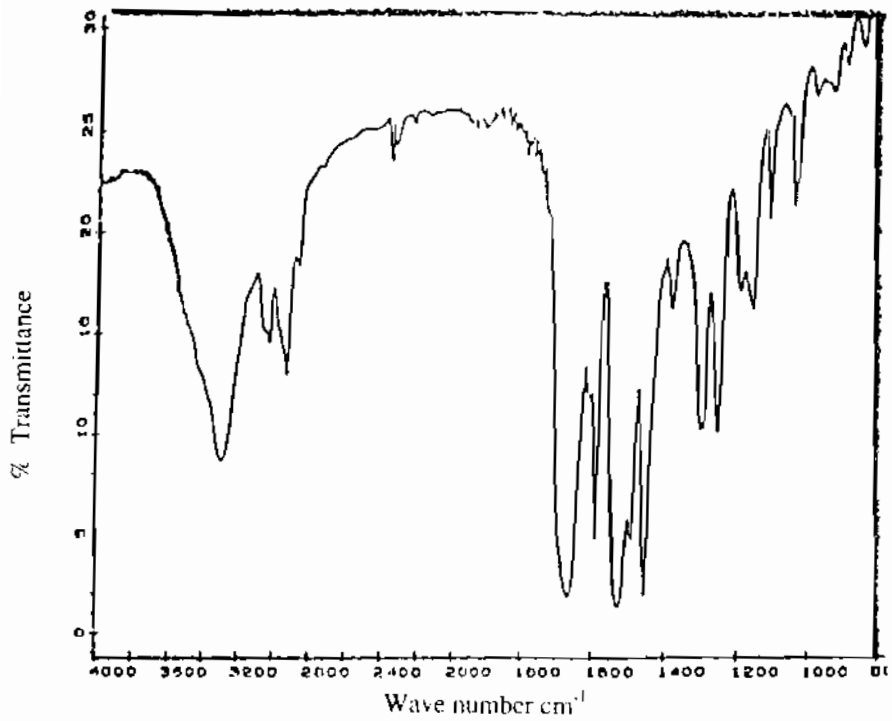



Fig. 4. IR spectrum of PMPM.

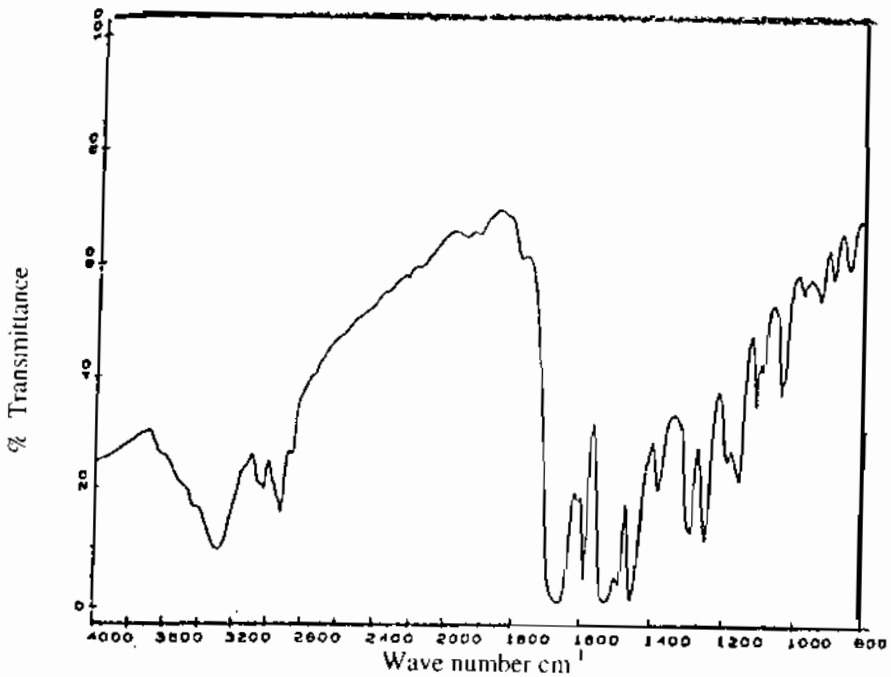



Fig. 5. IR spectrum of PMPM-Copper acetate.

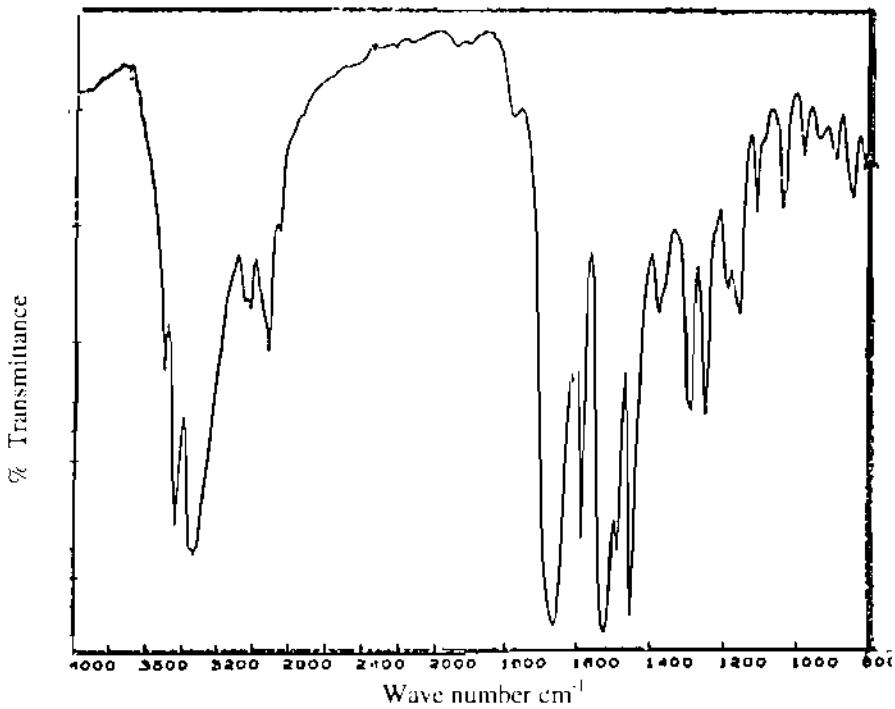



Fig. 6 IR spectrum of PMPM-Copper chloride.

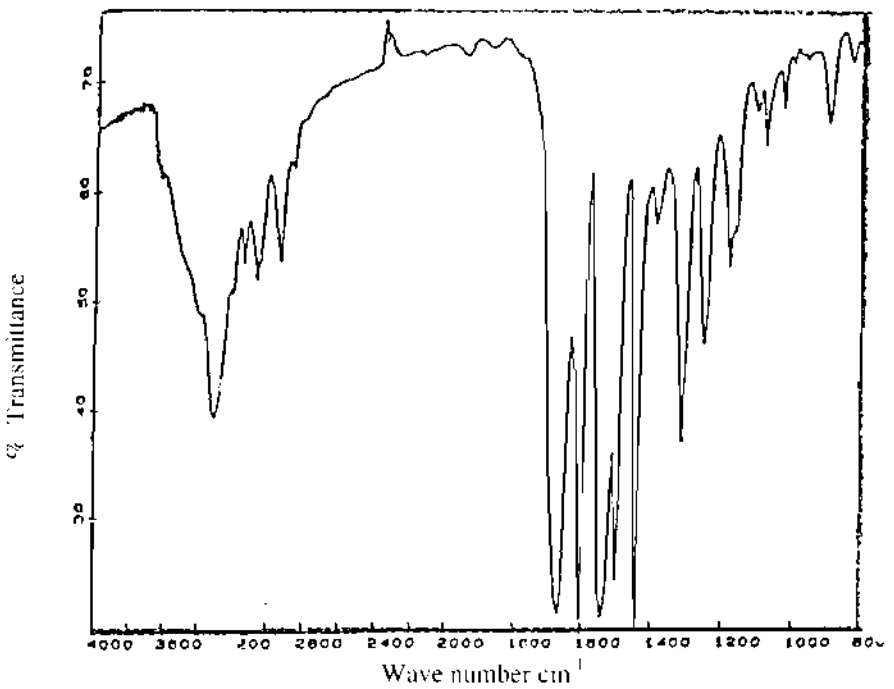



Fig. 7. IR spectrum of PMOM.

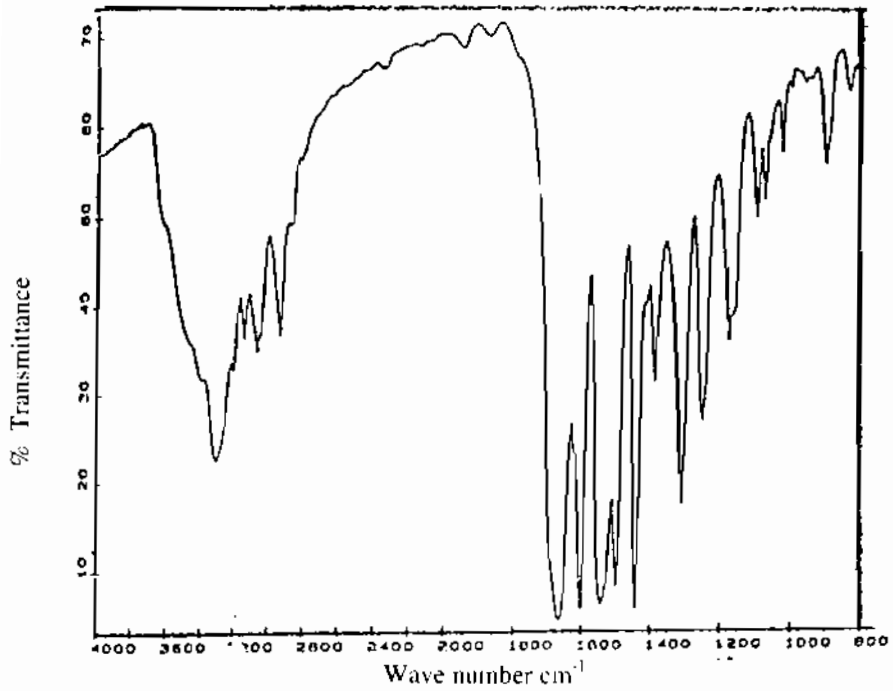



Fig. 8. IR spectrum of PMOM-Copper acetate.

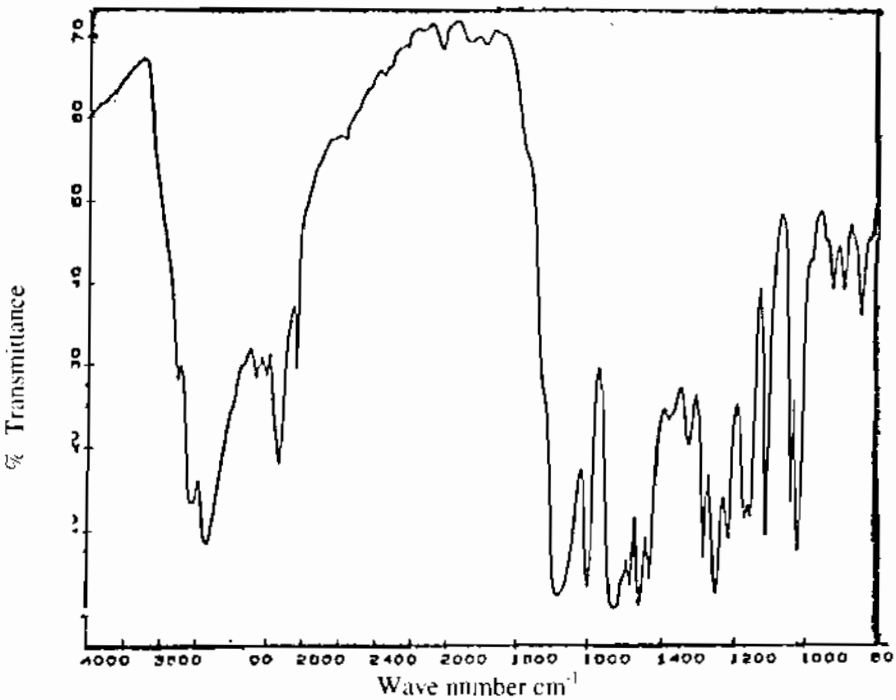



Fig. 9. IR spectrum of PMOM-Copper chloride.

Table 7. IR bands assignment for PMOM.

| Band | Assignment | Band | Assignment |
|---|---|---|---|
| 3380 (s) | ν (OH) free | 3120 | ν (N–H) |
| 2920, 2810 | ν (C–H) | 1655 | Amide I band ν (C = O) |
| 1525 | Amide II band ν (C=N) + δ (N–H) | 1600 | Benzene ring |
| 1380 | C–H symm. deform. of $CH_3$ | 1490, 1450 | Benzene ring |
| 1340 | Amide III band δ ( C–N) | 900, 850 | δ (C–H) bending |

Table 8. Micro-analytical data for PPM-metal complexes.

| Compound | Analysis (%) Found/(calculated) | | | |
|---|---|---|---|---|
| | % C | % H | % N | % M |
| PPM - Cu acetate | 60.1 (59.77) | 6.17 (6.05) | 6.30 (6.15) | 8.98 (9.30) |
| PPM - Cu chloride | 57.01 (56.65) | 5.78 (5.55) | 6.50 (6.61) | 10.20 (9 99) |

Table 9. Micro-aualytical data for PMPM-metal complexes.

| Compound | Analysis (%) Found/(calculated) | | | |
|---|---|---|---|---|
| | % C | % H | % N | % M |
| PMPM - Cu acetate | 61.80 (61.27) | 6.60 (6.53) | 6.01 (5.79) | 9.00 (8.76) |
| PMPM - Cu chloride | 58.01 (58.45) | 6.30 (6.09) | 5.98 (6.20) | 9.70 (9.37) |

Table 10. Micro-analytical data for PMOM-metal complexes.

| Compound | Analysis (%) Found/(calculated) | | | |
|---|---|---|---|---|
| | % C | % H | % N | % M |
| PMOM - Cu acetate | 58.00 (57.47) | 6.40 (6.13) | 5.80 (5.43) | 8.60 (8.22) |
| PMOM - Cu chloride | 54.10 (54.58) | 5.91 (5.69) | 6.08 (5.79) | 8.98 (8.75) |

Table 11. IR bands assignment for PPM - metal complexes.

| PPM - Cu acetate | PPM - Cu chloride | Assignment |
|---|---|---|
| | 3460 | ν (O – H) free |
| 3320 | 3330 (s) | ν (O – H) bonded |
| 3150 | 3150 | ν (N – H) |
| 2935, 2870 | 2940, 2870 | ν (C–H) |
| 1665 (s) | 1665 (s) | Amide I baud ν (C = O) |
| 1600 (s) | 1600(s) | Benzene ring |
| 1550 (s) | 1550 (s) | Amide II band ν (C = N) + δ (N – H) |
| 1510 (s) | 1510 (s) | Benzene ring |
| 1450 (s) | 1450 (s) | benzene ring |
| 1400 (w) | | ν (OAc) |
| 1375 | 1375 | ν (C–H) symm. deform. of CH3 |
| 1325 (s) | 1325 (s) | Amide III band δ (C – N) |
| 910 (m) | 910 (m) | δ (C – H) |
| 850 (w) | 850 (w) | δ (C – H) bending |

***The IR-spectra of all polymer complexes showed the following***

1- The ν (N – H) are shifted to a lower frequency in the polymer complexes, suggesting the coordination of the polymers to the metal ions through the nitrogen of the (N – H) group.

2- The ν (C = O) bands are unaffected upon complexation indicating that the carbonyl is not bonded to the metal ion in all complexes. Depending upon IR-spectra and micro-analytical data, the following structures (Schemes 1-3) are suggested for the polymer complexes.

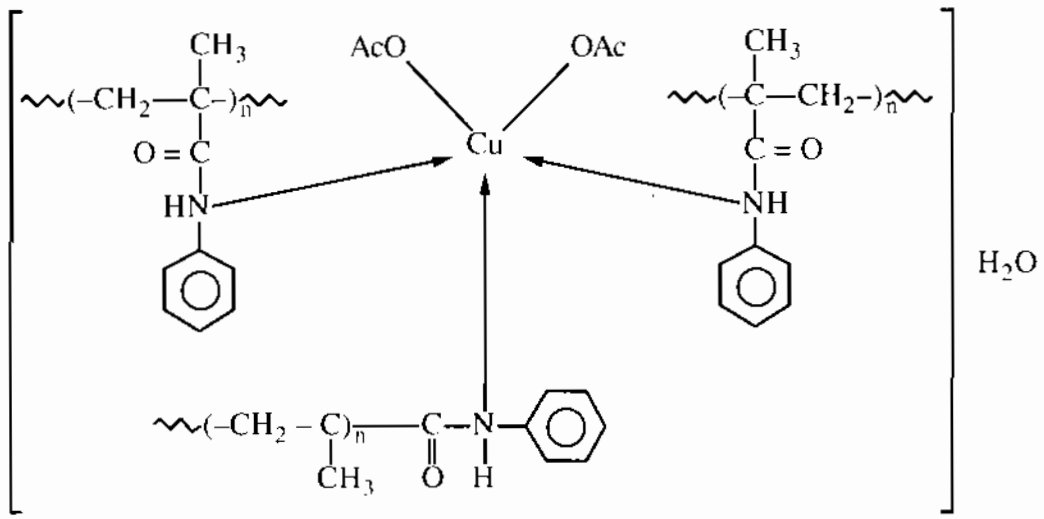
Table 12. IR bands assignment for PMPM - metal complexes.

| PMPM - Cu acetate | PMPM - Cu chloride | Assignment |
|---|---|---|
| | 3460 (s) | ν (O – H) free |
| 3300 | 3330 (s) | ν (O – H) bonded |
| 3030 | 3030 | ν (N–H) |
| 2930, 2860 | 2930, 2860 | ν (C–H) |
| 1660 (s) | 1660 (s) | Amide I band ν (C = O) |
| 1590 (s) | 1590(s) | Benzene ring |
| 1535 (s) | 1535 (s) | Amide II band ν (C = N) + δ (N – H) |
| 1490 (w) | 1490 (w) | Benzene ring |
| 1460 (s) | 1460 (s) | benzene ring |
| 1400 (w) | | ν (OAc) |
| 1380 | 1380 | ν (C–H) symm. deform. of $CH_3$ |
| 1300 (s) | 1300 (s) | Amide III band δ (C – N) |
| 900 (m) | 900 (m) | δ (C - H) |
| 860 (m) | 860 (m) | out of plane δ (C – H) bending |

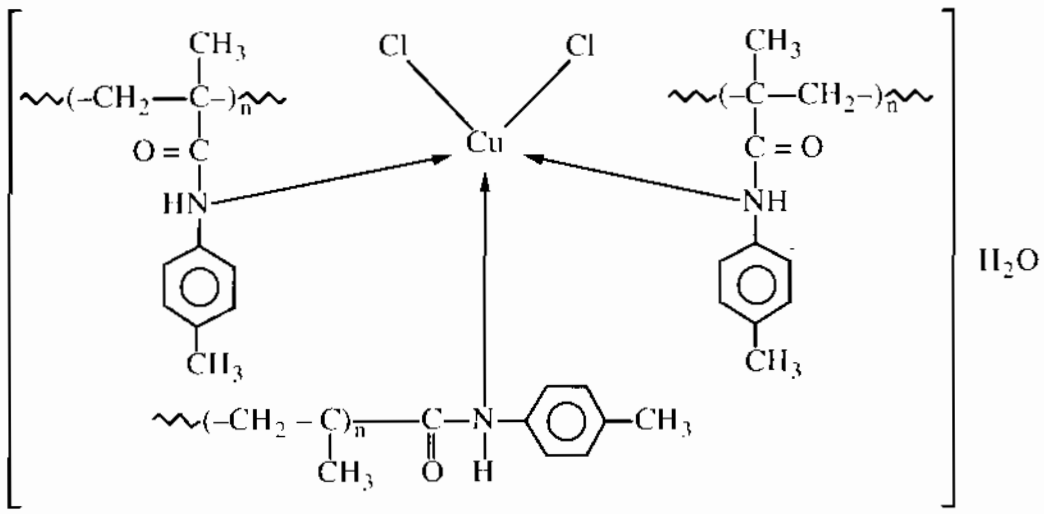
Table 13. IR bands assignment for PMOM - metal complexes.

| PMOM - Cu acetate | PMOM - Cu chloride | Assignment |
|---|---|---|
| | 3435 (s) | ν (O – H) free |
| 3310 (s) | | ν (O – H) bonded |
| 3030 | 3030 | |
| 2910, 2850 | 2960, 2850 | ν (C–H) |
| 1655 (s) | 1655 (s) | Amide I band ν (C = O) |
| 1600 (s) | 1600(s) | Benzene ring |
| 1530 (s) | 1535 (s) | Amide II band ν (C = N) + δ (N – H) |
| 1500 (w) | 1490 (w) | Benzene ring |
| 1460 (s) | 1450 (s) | benzene ring |
| 1400 (w) | | ν (OAc) |
| 1380 | 1380 | ν (C–H) symm. deform. of CH3 |
| 1330 | 1330 | Amide III band δ (C – N) |
| 900 | 900 | δ (C – H) |
| 850 | 850 | out of plane δ (C – H) bending |

Depending upon IR-spectra and micro-analytical data, the following structures (Schemes 1-3) are suggested for the polymer complexes.

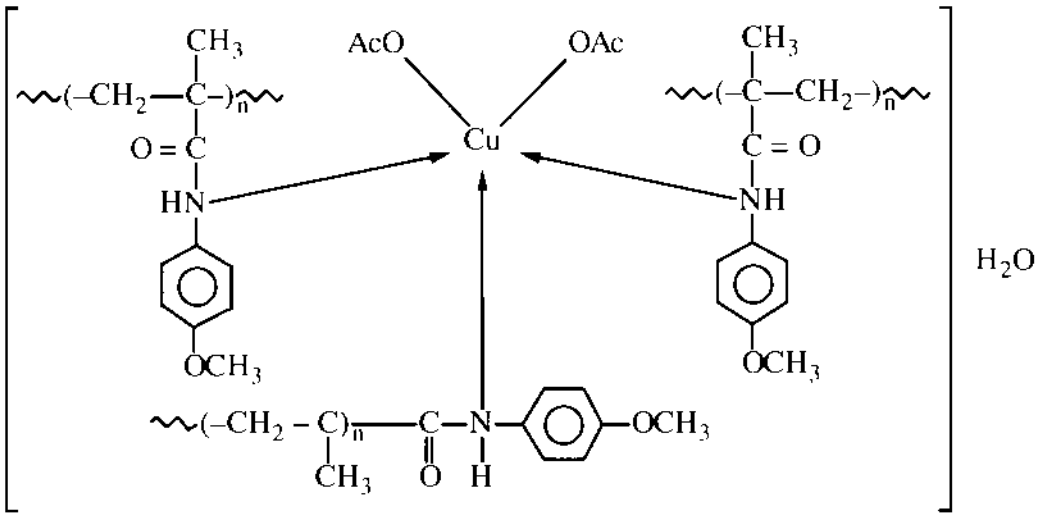



PMM - Cu acetate

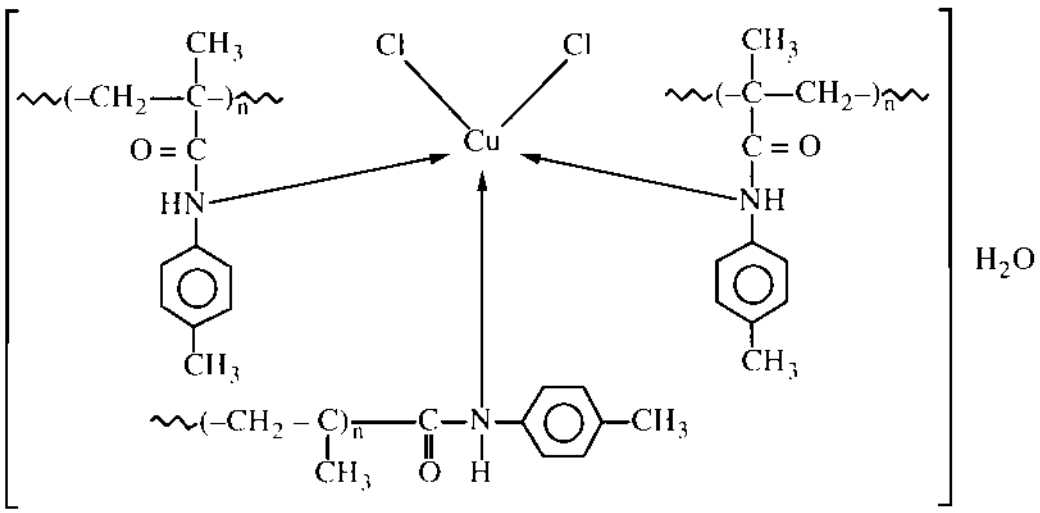



PMM - Cu chloride

Scheme 1. Suggested structure for the PPM - Cu - complexes.

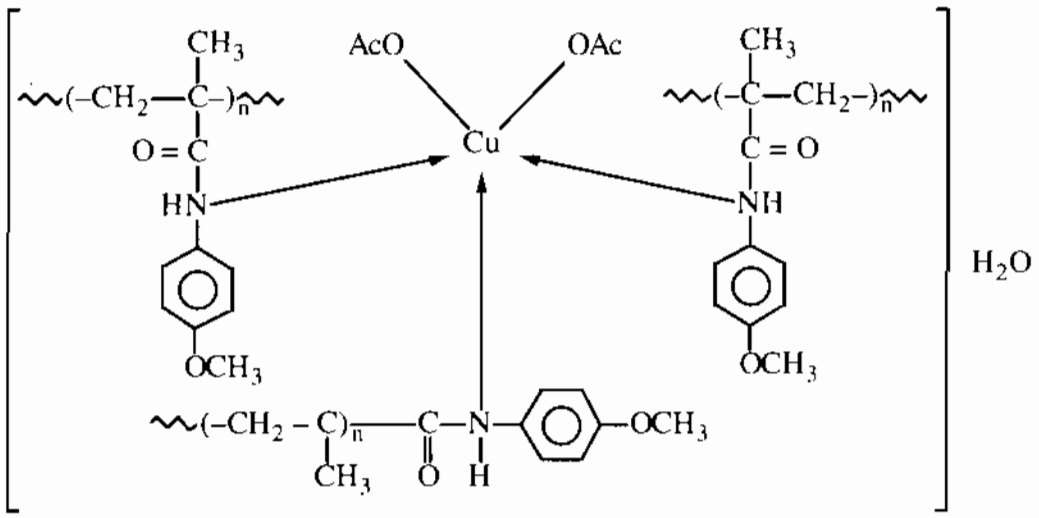



PMPM - Cu acetate

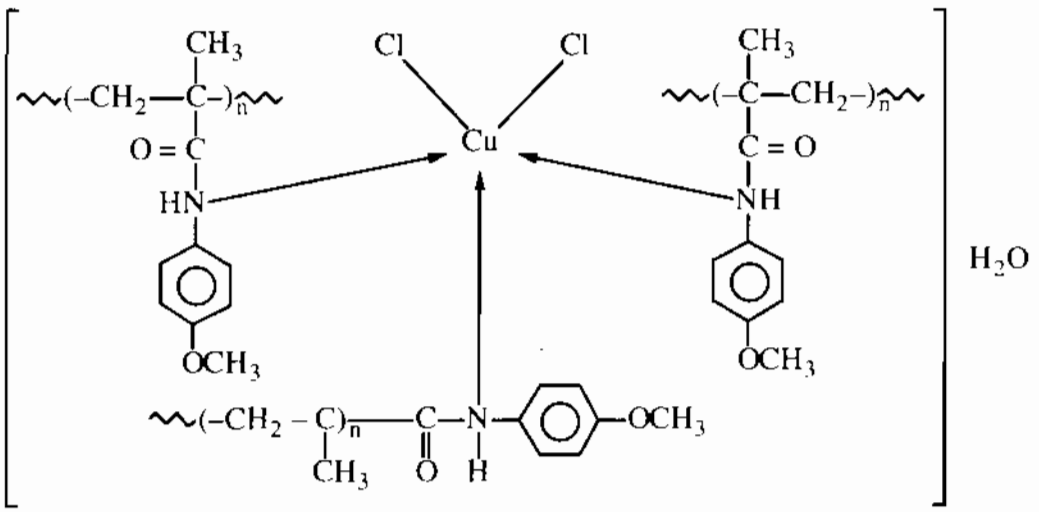



PMPM - Cu chloride

Scheme 2. Suggested structure for the PMPM - Cu - complexes.




PMOM - Cu acetate




PMOM - Cu chloride

Scheme 3. Suggested structure for the PMOM-Cu-complexes.

Thermo-analytical results of PPM and its complexes are shown in Table 14.

Table 14. Thermo-analytical results of PPM and its metal complexes.

| Compound | DTA | | TGA |
|---|---|---|---|
| | $T_{range}$ (°C) | $T_{max}$ (°C) | wt. loss (%) for stage |
| PPM | | 90 – 170 | - |
| | | 250 – 530 | 418 |
| PMM - Cu acetate | 95 – 192 | - | 3.4 |
| | 230 - 630 | 430 | 77 |
| PMM - Cu chloride | 100 -290 | - | 10.5 |
| | 290 – 390 | 360 | 27 |
| | 390 - 610 | 440 | 43.5 |

Two stages of decomposition were observed for PPM (Fig. 10). The first one occurs in the temperature range 90 - 170°C (3.5% wt. loss) and is assigned to a loss of solvent molecules. The second stage started at 250°C and ended at 530°C with 88% wt. loss.

Two stages of decomposition were observed for PMM - Cu acetate (Fig. 11) and three stages were ohserved for PPM - Cu chloride complexes (Fig. 12). The first weight loss for PPM - Cu acetate occurred between 95 - 192°C (3.4% wt. loss) and is equivalent to the loss of a water molecule. The second stage appeared between 230°C and 630°C with 77% wt. loss. For PPM - Cu chloride complex, the first weight loss occurred between 100 and 290°C with 10.5% weight loss, which may be due to the loss of a water molecule. The second step occurred in the temperature range 290 - 390°C. The third step started at 390°C and ended at 610°C (43.5% wt. loss).

Thermo-analytical results of PMPM homopolymer and its metal complexes are shown in Tahle 15. Two stages of decomposition were observed for the homopolymer (Fig. 13). The first one occurs in the temperature range 185 - 300°C (10.2% wt. loss). The second stage started at 350°C and ended at 525°C with 76.3% wt. loss.

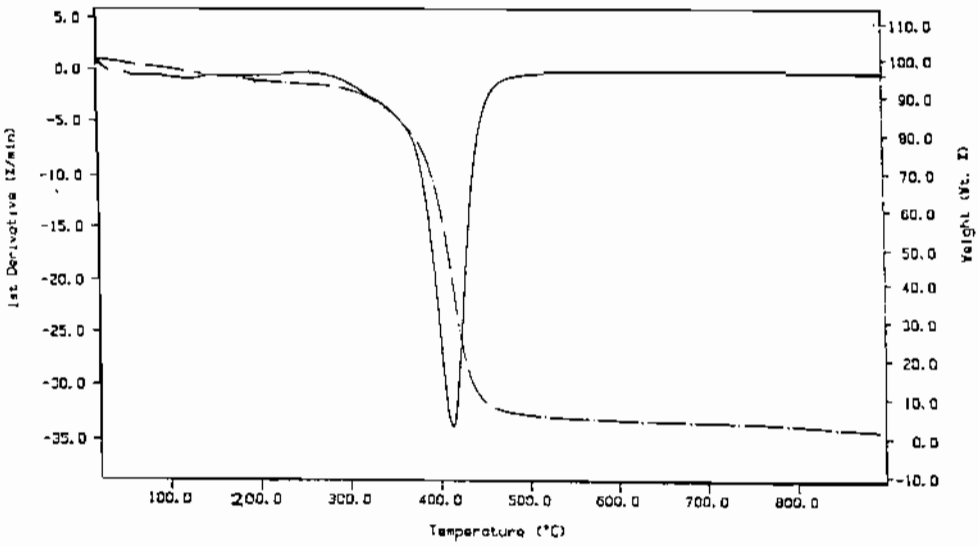



Fig. 10. Thermogravimetric analytical spectrum of PPM.

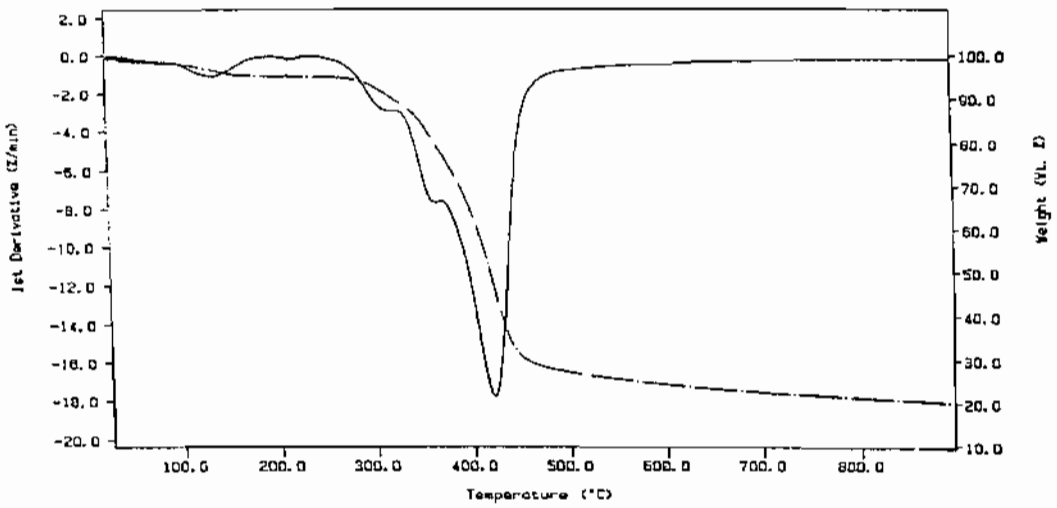



Fig. 11. Thermogravimetric analytical spectrum of PPM-Cu-acetate complex.

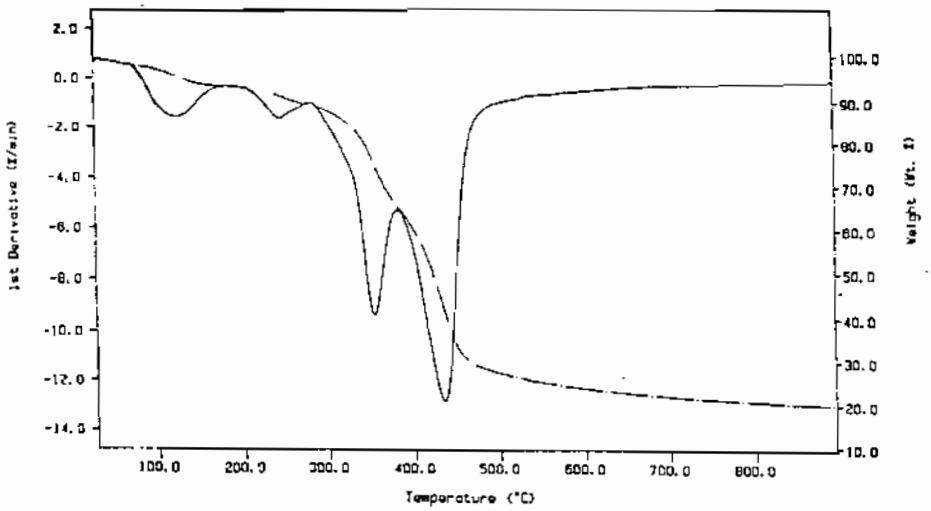



Fig. 12. Thermogravimetric analytical spectrum of PPM-Cu-chloride complex.

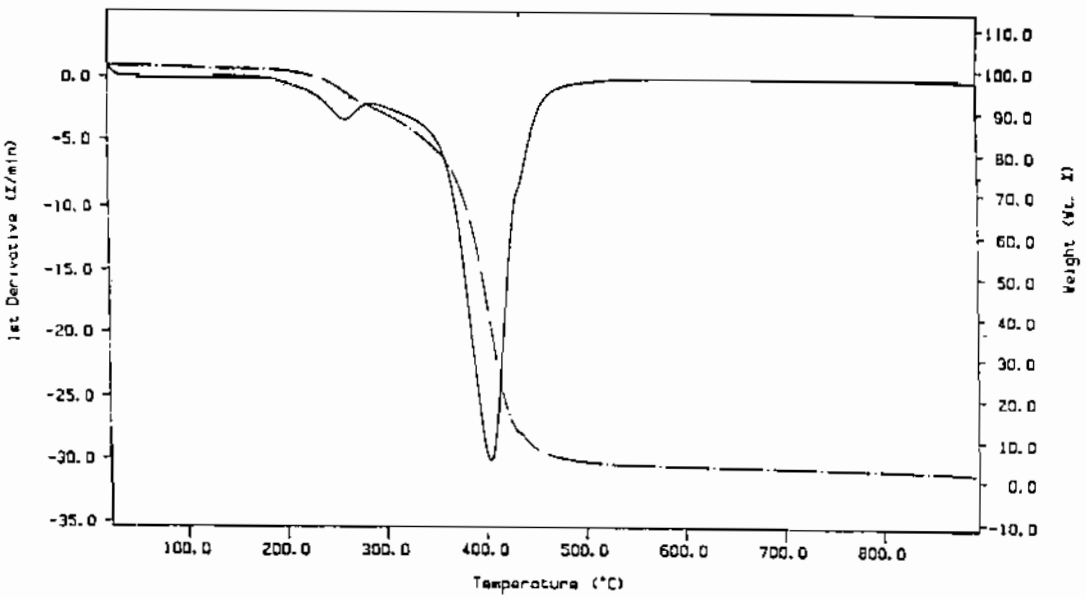



Fig. 13. Thermogravimetric analytical spectrum of PMPM.

Three stages of decomposition were observed for PMPM - metal complexes (Fig. 14) and (Fig. 15). The first step in case of PMPM - Cu acetate appeared in the temperature range 95 - 180°C with 2.8% wt. loss which may be due to the loss of a water molecule. The first weight loss stage for PMPM - Cu chloride was observed in the temperature range 100 - 316°C with a weight loss 5.25% which may be due to the loss of a water molecule. The second stage for Cu (II) acetate complex was observed in the temperature range 270 - 396°C (29% wt. loss). The second step in case of Cu (II) Chloride complex appeared in the temperature range 316 - 392°C (20.4% wt. loss). The third stage occurred in the temperature range 396 - 580°C (36.9% wt. loss) for Cu (II) acetate complex and in the temperature range392 - 670°C (41% wt. loss) for Cu (II) chloride complex.

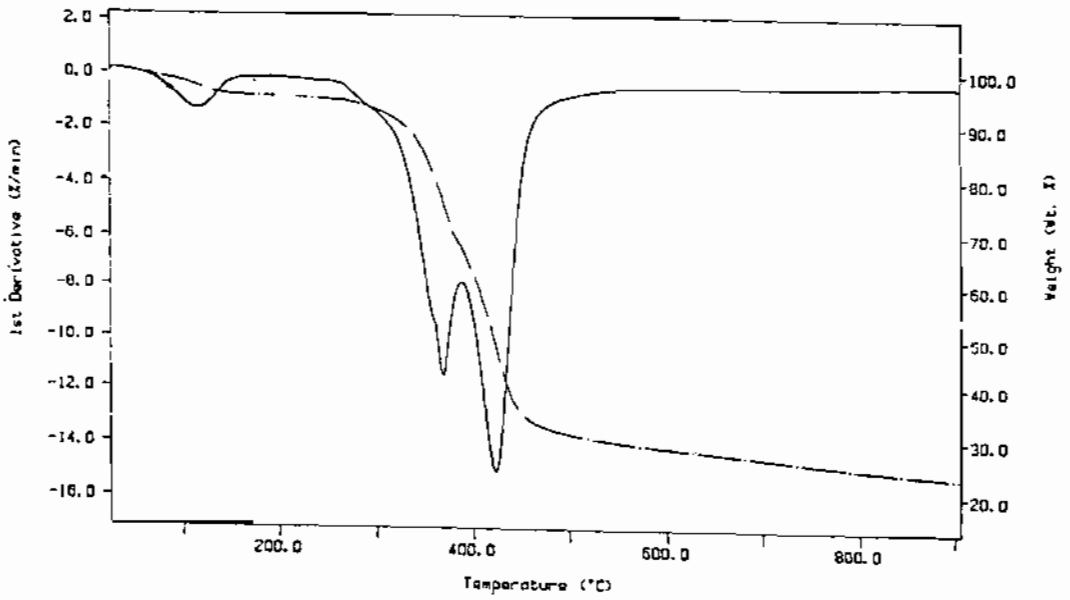



Fig. 14. Thermogravimetric analytical spectrum of PMPM-Cu-acetate complex.

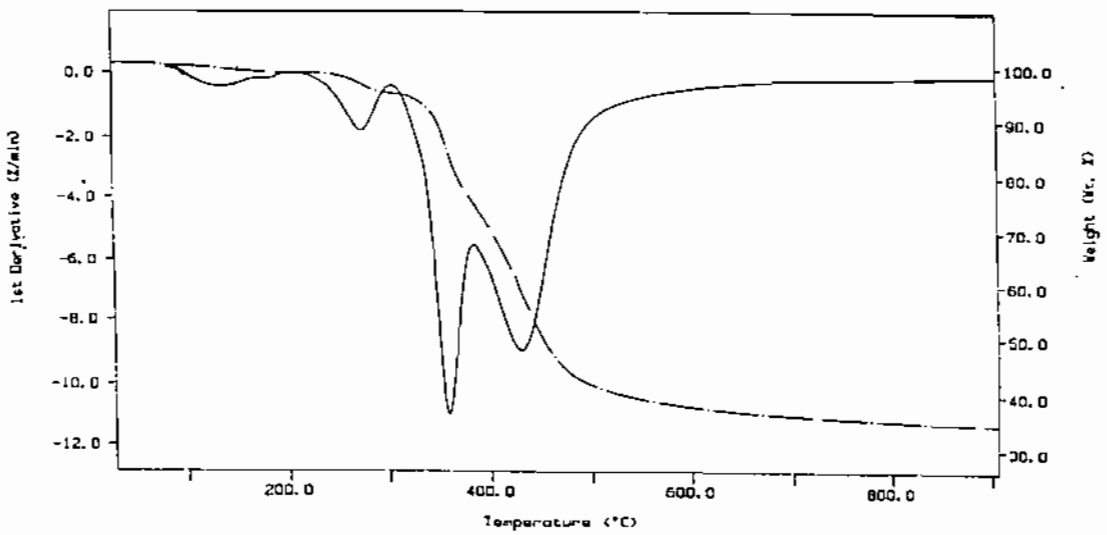



Fig. 15. Thermogravimetric analytical spectrum of PMPM-Cu-chloride complex.

Table 15 Thermo-analytical results of PMPM and its metal complexes.

| Compound | DTA | | TGA |
|---|---|---|---|
| | $T_{range}$ (°C) | $T_{max}$ (°C) | wt. loss (%) for stage |
| PMPM | 185 – 300 | 265 | 10.5 |
| | 350 – 525 | 400 | 76.3 |
| PMPM - Cu acetate | 95 – 180 | – | 2.8 |
| | 290 – 396 | 382 | 29.0 |
| | 396 – 580 | 441 | 36.9 |
| P PMPM - Cu chloride | 100 – 316 | – | 5.25 |
| | 316 – 392 | 362 | 20.4 |
| | 392 – 670 | 438 | 41.0 |

Thermo-analytical results of PMOM and its complexes are collected in Table 16. PMOM decomposed in three stages (Fig. 16).

The first one occurs in the temperature range 90 - 180°C (3.35% wt. loss) and was assigned to a loss of solvent molecules. The second stage started at 276°C and ended at 340°C with 10.2% wt. loss. The third stage of decomposition ended at 537°C with 77% wt. loss

Cu (II) acetate and Cu (II) chloride complexes decompose in three stages (Fig. 17) and (Fig. 18). The first weight loss appeared in the temperature range 100 -296°C (7.15% wt. loss) for Cu (II) acetate and 100 -290°C (9.8% wt. loss) for Cu (II) chloride complex. The second step for Cu (II) acetate complex occurred between 296 and 385°C with 23.3% weight loss while for Cu (II) chloride complex appeared between 290 - 380°C (23% wt. loss). The third weight loss stage was observed in the range 385 - 570°C (42.5% wt. loss) for Cu acetate complex and in the range 380 - 650°C (40.3% wt. loss) for Cu chloride complex.

The TG and DTA results for homopolymers and their corresponding copper complexes showed that the thermal stabilities of homopolymers are lower than that of their copper complexes. This may be due to the formation of stable structures in these polymer complexes.

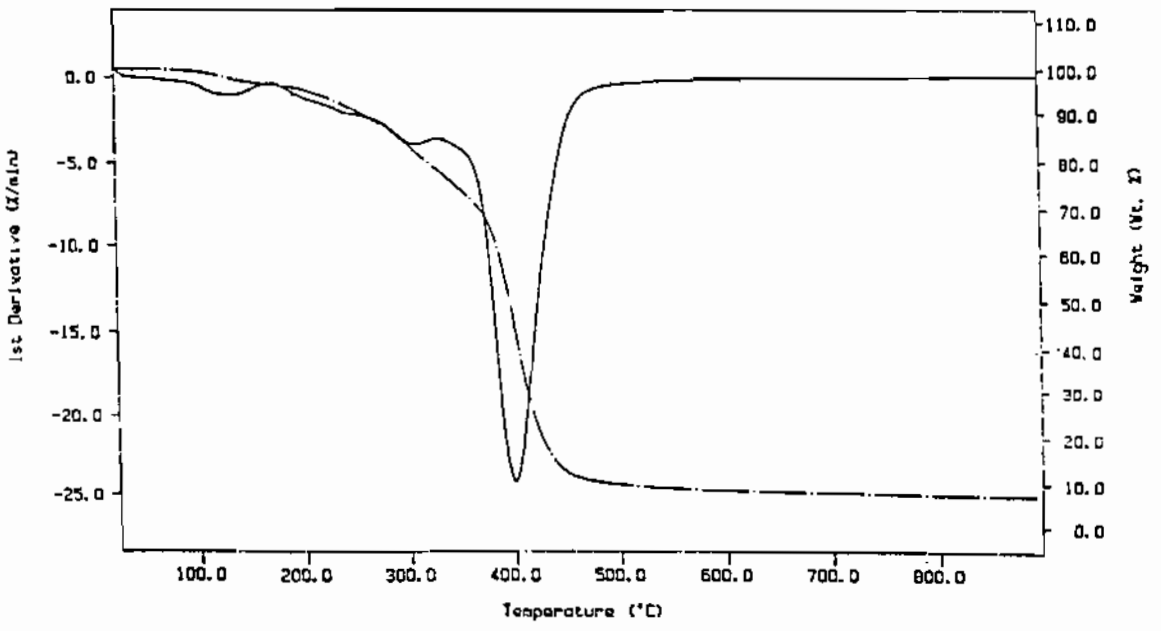



Fig. 16. Thermogravimetric analytical spectrum of PMOM.

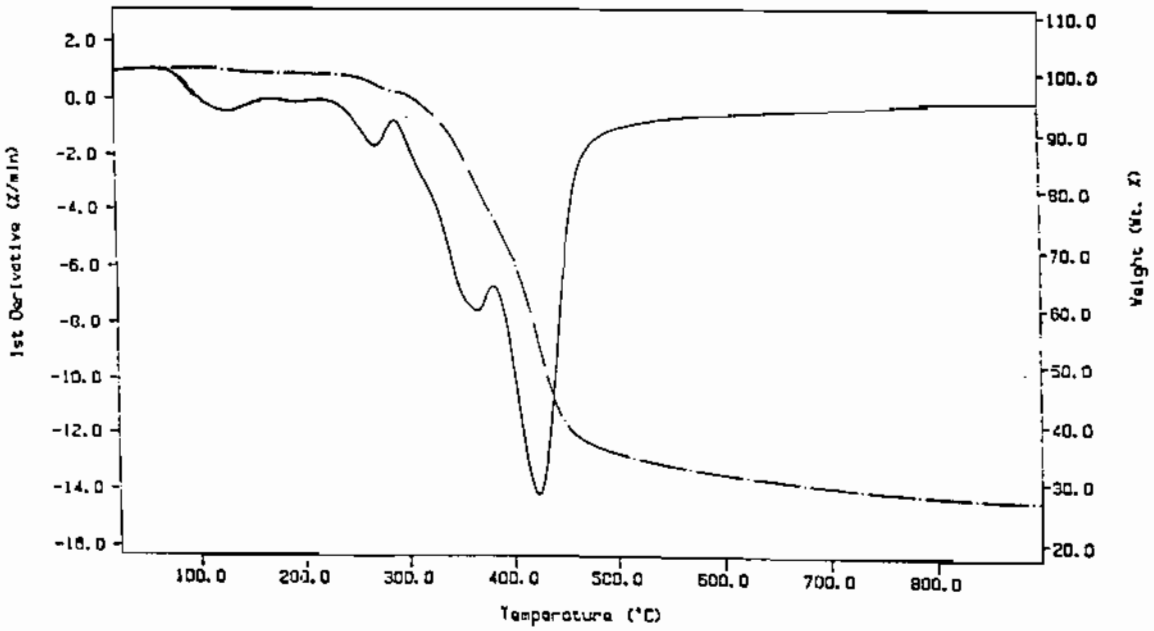



Fig. 17. Thermogravimetric analytical spectrum of PMOM-Cu-acetate complex.

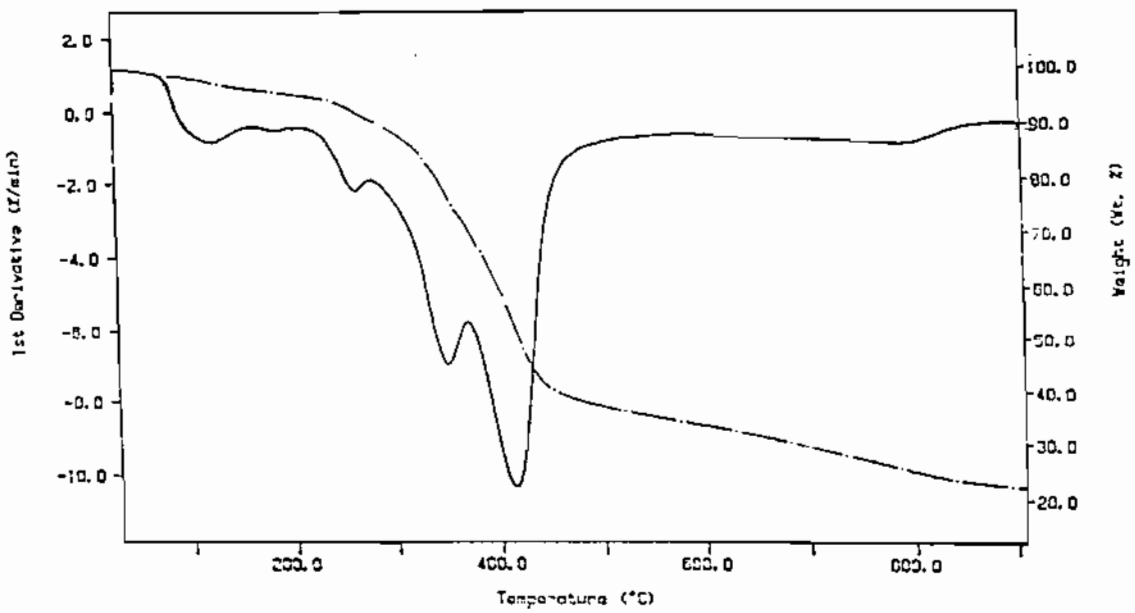



Fig. 18. Thermogravimetric analytical spectrum of PMOM-Cu-chloride complex.

Table 16. Thermo-analytical results of PMOM and its metal complexes.

| Compound | DTA | | TGA |
|---|---|---|---|
| | $T_{range}$ (°C) | $T_{max}$ (°C) | wt. loss (%) for stage |
| PMOM | 90 – 180 | – | 3.35 |
| | 268 – 340 | 300 | 10.2 |
| | 340 – 537 | 405 | 77.0 |
| PMOM - Cu acetate | 100 – 296 | – | 7.15 |
| | 296 - 385 | 360 | 23.3 |
| | 385 – 570 | 420 | 42.5 |
| PMOM - Cu chloride | 100 – 290 | – | 9.8 |
| | 290 – 380 | 345 | 23.0 |
| | 380 – 650 | 415 | 40.3 |

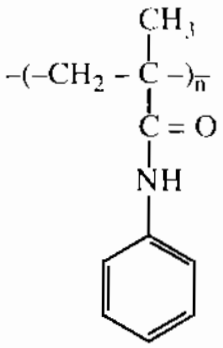
## Conclusion

1- In this work monomers of N-phenyl methacrylamide, N-(p-methyl phenyl) methacrylamide and N-(p-methoxy phenyl) methacrylamide were prepared and the optimum conditions for their polymerization were investigated by following the polymerization time, effect of ratio of initiator, and effect of solvent.

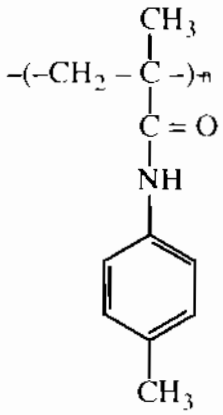
The optimum time condition of polymerization is 5 hrs, when benzene is used as a solvent, and the ratio of initiator is 5% (w/w).

2- The polymers obtained were characterized by determining the viscosity number, Infrared spectroscopy, elemental analysis, metal analysis, and thermo gravimetric analysis (TGA).

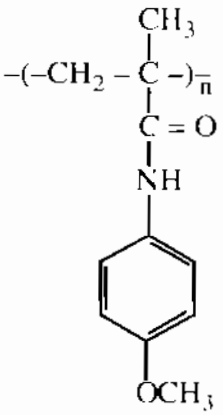
The micro-analytical data confirmed the following structures of the prepared polymers :



(PPM)



(PMPM)



(PMOM)

3- The TGA and DTA results for homopolymers and their corresponding copper complexes showed that the thermal stabilities of homopolymers are lower than that of their copper complexes. This may be due to the formation of stable structures in these polymer complexes.

***Acknowledgements***

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# تحضير مبلمرات الأكريليك مقاومة الحرارة

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*جـــــدة – المملكة العربية السعودية*

*المستخلص.* تـم تحضـير منـومـــرات {N-phenyl methacrylamide (PPM)} و{N-(p-methyl phenyl) methacrylamide (PMPM)} و {N-(p-methoxy phenyl) methacrylamide (PMOM)} وتمت دراسة أفضل شروط بلمرتها بمتابعة زمن البلمرة وتأثير نسبة البادئات وتأثير المذيبات . تم توصيف البوليمرات المحضرة بتحديد عـدد اللزوجة واستخدام طيف الأشعة تحت الحمراء والتحليل الدقيق وتحليل العناصر كما تم فحص السلوك الحراري للبوليمرات ومركباتها باستخدام التحليل الوزني الحراري .

نتائج التحليل الدقيق وطيف الأشعة تحت الحمراء أكدت المبلمرات المحـضرة وبالرجوع إليها تم اقتراح مخططات لمركبات المبلمرات مع المعادن . ومـن ناحيـة أخرى أظهر التحليل الوزني الحراري مرحلتين إلى ثلاث مراحل تحلل للمنـومرات ولمركبات البوليمرات.