Preparation and Characteristics of (Poly Methyl Methacrylate' / Poly Vinyl Pyrrolidone) Blend

Mehdi Edan Mehdi[1*], Asmaa Shawqy Khaleel[2]

Abstract

Special attention, has been /focused on. the development: of Polymer blends' in recent, years. It is a member; of a class of materials' analogous to metal, alloys, in which at' least two polymers, are blended together to create, a new material with / different properties. In the present study, Poly (methyl methacrylate) (PMMA) / Polyvinylpyrrolidone (PVP) blends with different weight ratios Poly methyl methacrylate (PMMA) widely used as and the liquid part of methyl methacrylate (MMA) monomer a prosthodontic denture resin, the denture materials resin should exhibit good physical and mechanical properties. In the present research, efforts are made to develop the properties of PMMA resin that used for upper and lower prosthesis complete denture, by different ratios of (0, 2%, 6%, 10%, 14%, 18%, 22%, 26%) to poly methyl methacrylate (PMMA), cold cured. The blend formation has been confirmed from Fourier transform infrared (FTIR), SEM, DSC - TGA and toxicity. By studying DSA and TGA, The DSC test results show that the glass transition temperature (Tg) value is equal (178) c0 and melting point between (368-372) for all concentrations of PMMA/PVP blends. Surface topography and morphology of PMMA-PVP shown by SEM. The results of the toxicological examination showed that the lowest toxicity appeared at a concentration of 78% - 22% for PMMA- PVP. The best results appear in (22%) PVP and (78%) PMMA.

Key Words: Mechanical Properties, PMMA, PVP, Toxicity.

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Introduction

Polymethylmethacrylate (PMMA) acrylic resins are used for over 70 years in fabricating complete dentures, PMMA is one of the most widely used industrial polymeric materials and still remains an active material for research at the cutting edges of science. Because of its good biocompatibility, reliability, dimensional stability, absence of taste, odor, tissue irritation and toxicity (1-2). Polymer blends are the mixture of two or more polymers that can either mix completely on a molecular scale or form two-phase structure. Polymer blends exhibit a new combination of properties of component and depend strongly on the morphology of the blended materials (3-4). Hence there are few methods proposed by Mallikarjuna et al. [5-6-7] to improve the properties of PMMA resin such as:

- Using polycarbonates and polyamides as substitutes for PMMA.
- Chemical modification of PMMA by the addition of copolymers, cross-linking agents and rubber substances in the form of butadiene styrene.
- The incorporation of fibers, metal or ceramic inserts into the denture bases act as filler. According to Rajul and Romesh (8-9). PMMA based materials are widely used as biomaterials. Nowadays, PMMA finds applications not only in dentistry but also in areas such as transparent glass substitutes, interior design, and transparent dielectric films (10-11-12).

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The aim of this study is to prepare and characterizes (PMMA \ PVP) blend.

Materials and Experimental Works

1. Materials used Poly methyl methacrylate (PMMA) self-curing is the powder material which was used in current work, as a pour type resin powder material, manufactured by (Sofa Dental) company, and multifunctional self-polymerizing acrylic. Some properties of (PMMA) time of solubility 4 min, resistance to impact 0,4 j/cm ^{2}, bending strength 65,5 Mpa and Brinley hardness 120 Mpa.
2. Polyvinyl pyrrolidone of PVP is Anhui Leaf hem co, Ltd, China (mainland). Meting temperature Tm150-190 C^0 Cure temperature and glass transition temperature 60-75 C^0 (13).

Preparation Methods of Test Specimens

Preparation of PMMA/PVP polymer blends

Poly methyl methacrylate of varying mass (100, 98, 94, 90, 86, 82, 78, 74) g was dissolved in (10_50 ml) of methyl methacrylate (MMA) monomer. Polyvinylpyrrolidone of varying mass (0, 2, 6, 10, 14, 18, 22, 26) was added. The mixture was put in packer at 10 minutes and poured into models made of glass prepared according to the type of examination.

Characterization Techniques

FTIR study was carried out on the polymer blends using FTIR Bruker Vertex 70. The surface morphology of the polymeric Blends was analyzed using the SEM. The glass transition temperature (Tg) value is equal from TGA and DCA.

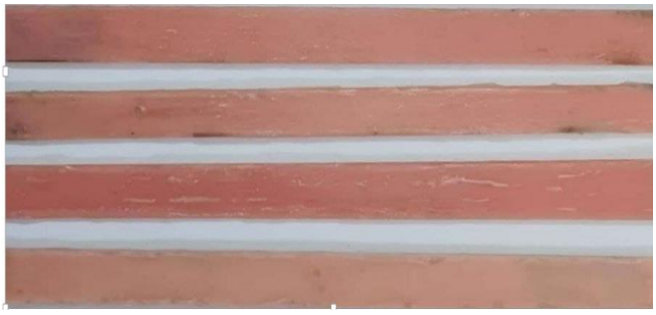


Fig. 1. The PMMA/PVP blend

Results and Discussion

Fourier Transforms Infrared Spectroscopy (FTIR)

Fourier transforms infrared spectroscopy (FTIR) was used, to fully characteristic band of PMMA / PVP blend specimens. Table (1) illustrated the infrared spectrum of neat PMMA /PVP blend and shows that the asymmetric and symmetric correspond to the (C–H) stretching of methyl group (C-H) assigned to peaks at 2921.12 and 2849.35 cm^{-1}respectively correspond with (C–H) stretching peaks at 2948.9 cm^{-1} of PMMA pure. Furthermore C=O and C-O bands appear at range (1500-2000 cm^{-1}) and (1000-1400) respectively. So, the medium strength of C=O stretching assigned at 1732 cm^{-1} correspond with 1722cm^{-1} and the bands at (1447.03 and 1385) cm^{-1} are associated with (C–C) symmetric and asymmetric stretching modes respectively. The 1239.54 cm^{-1} band is assigned to torsion of the methylene group C and the peak at 1189.98cm-1 for the band corresponds to vibration of the ester group (C–O), while (C–CH) stretching band are at (992.15 and 844.11) cm^{-1} (5 and 6]. In this spectrum medium strength of C-H_2 bending assigned at 754.39 cm^{-1}. The infrared spectrum of PMMA reinforced with different ratios of polyvenelpoloradion (PVP) (6, 10, 14, 18, 22, and 26%). It can be seen from the infrared spectrum of these group blend specimens. The infrared spectrum is quite similar to that reported for many different natural compounds by [14-15]. There is a clear increase in peaks intensity for all of characteristic peaks of PMMA with increasing (PVP) powder ratio, and it reaches a maximum at ratio of 22%.

Table 1. Bonds type in the PMMA / PVP blend and its energy in cm^{-1}

Band Type	6% PVP	10% PVP	14% PVP	18% PVP	22% PVP	26% PVP
O-H	3439.25	3443.74	3439.25	3445.98	3445.98	3445.98
C-H stretch	2921.12	2918.88	2918.88	2921.12	2918.88	2921.12
C-H	2849.35	2849.35	2851.59	2851.59	2851.59	2851.59
C=O	1732.34	1730.09	1732.34	1732.34	1734.58	1732.34
C=C	1638.13	1638.13	1638.13	-	-	1644.86
C-C	1460.93	1465.42	1463.18	1465.42	1465.42	1463.18
C-O		1245.61	1245.61	1243.36	1245.61	1251.06
		1191.78	1194.02	1194.02	1194.02	1194.02
	1146.92	1144.67	1144.67	1149.16	1149.16	1149.16
		1063.93	1066.17	1066.17	1066.17	1063.93
C-H bending	992.15	846.36	841.87	841.87	844.11	844.11
C-H2 As symmetric	754.39	752.15	752.15	754.39	749.91	756.64

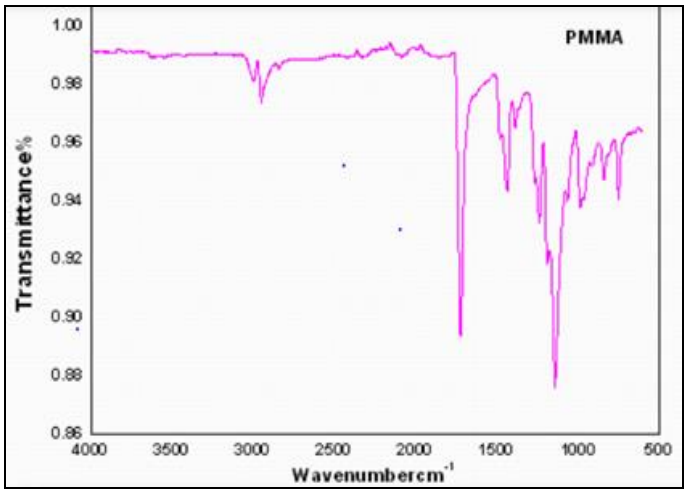


Fig. (2-a). FTIR spectrum of PMMA

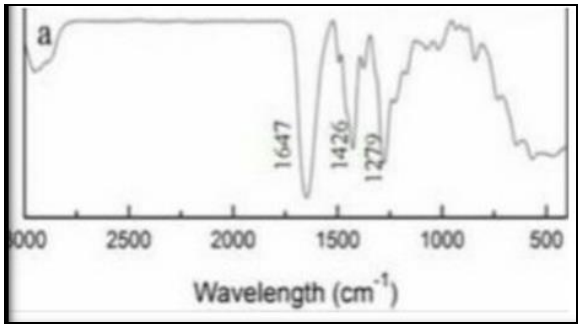


Fig. (2-b). FTIR spectrum of PVP

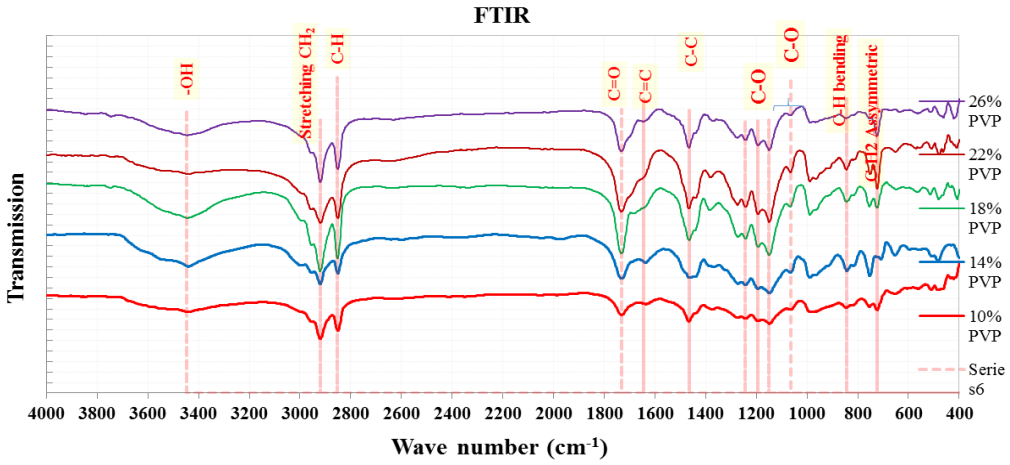
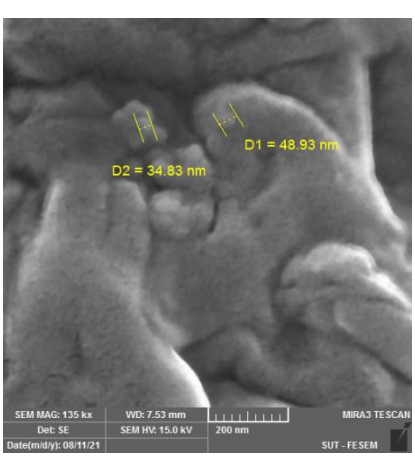


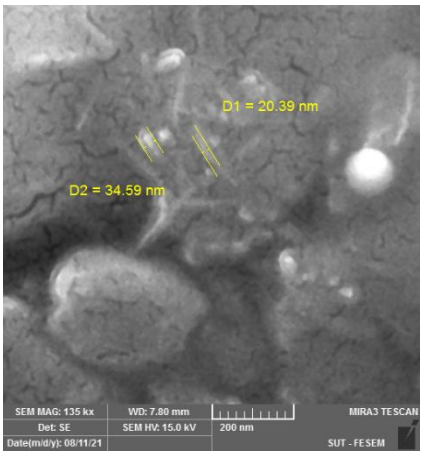
Figure 3. FTIR spectra for PMMA-PVP blend for different PVP concentrations

Scanning Electron Microscopy (FE-SE)

SEM photography of the surface morphology of PMMA powder and PMMA with (2, 6, 10, 14, 18, 22 and 26%) ratio of polyvinyl Pyrrolidone blend are shown in figure (4 a, b, c, d, e, f, n and m) respectively at magnifications with zoon power of all figure (a, b, c, d, e, f, n, and m170X). It is noticed from the surface morphology of SEM photography. This microscopic imaging exhibited a heterogeneous morphology. As well as, figure (4c, 3d) shows a continuous long morphology embedded in the material blend in the sample, figure (4e and 4f). The best morphology appear of figure (4n and m) surface morphology is homogeneous because of the strong bonds between molecular, but (4-a) appeared heterogeneous morphology in (SEM). This indicated to a good compatibility between the PMMA resin and PVP blend, which enhances the mechanical properties (16-17).

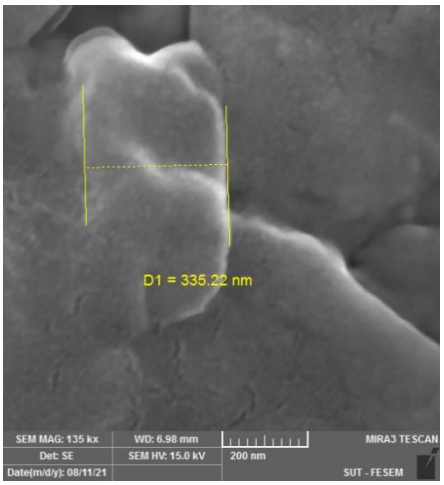


(4-a)

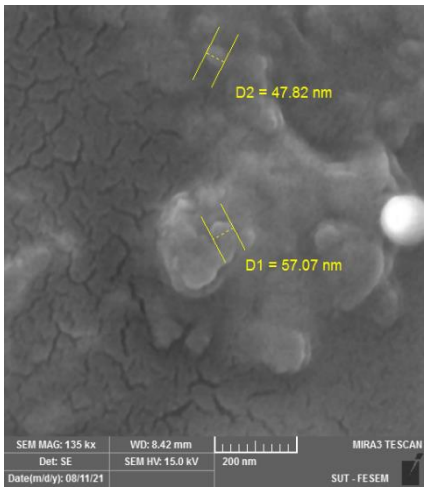


(4-b)

(4-c)



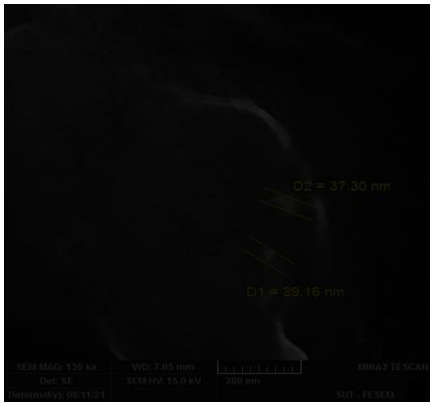
(4-d)



(4-e)

(4-f)

(4-n)



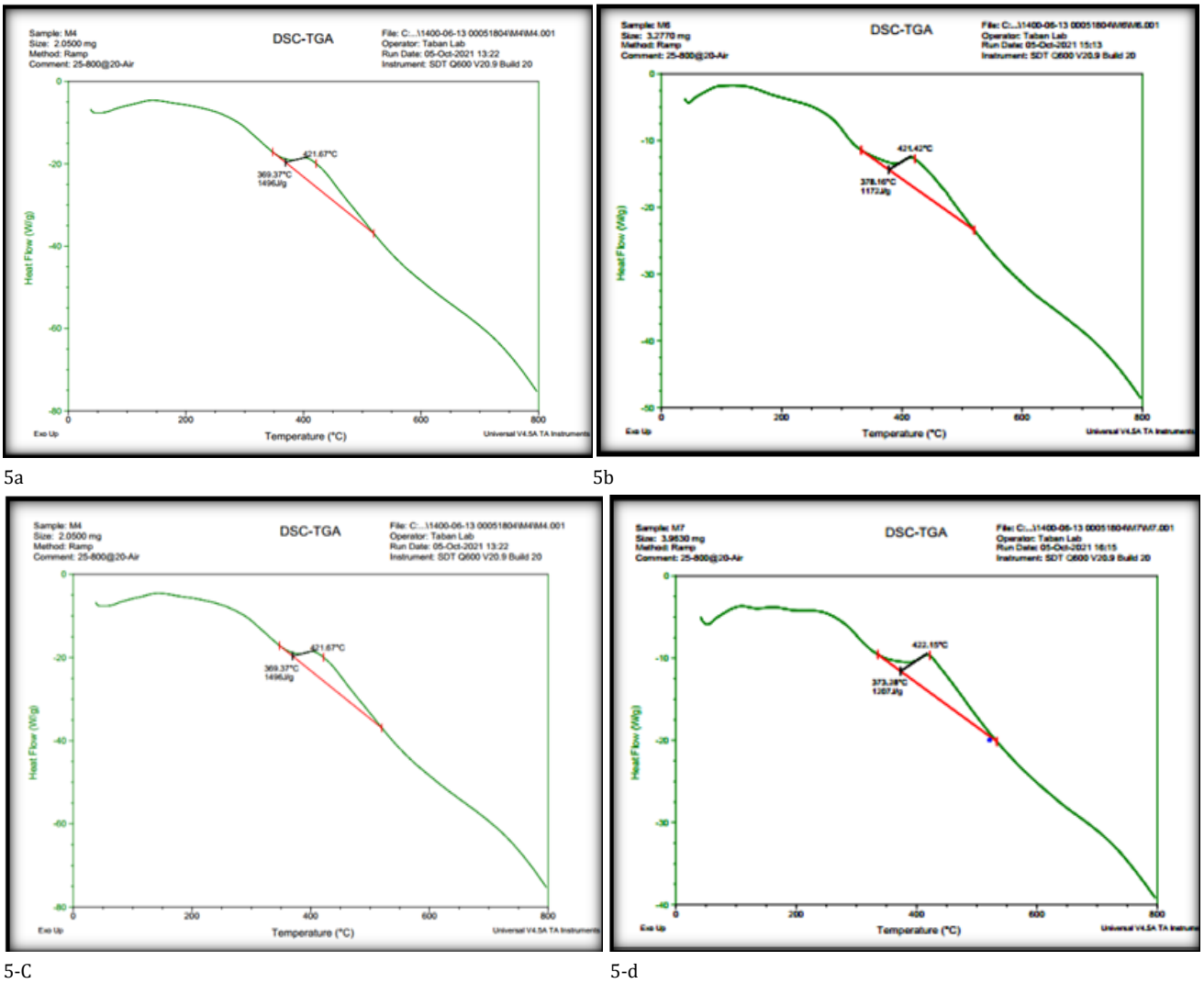
(4-m)

Figure 4. Show SEM for (PMMA /PVP)blend

Differential Scanning Calorimetric (DSC)

Thermal analyses were performed using a DSC instrument (DuPont TA 2010). The glass transition temperature (Tg) was obtained as the inflection point of the heat capacity jump recorded at a scan rate of 20 C/min. Thermo grams obtained for blend in Fig 6. Glass transition temperature (Tg) of the polymer concerns with the mobility of the polymer chain. One glass transition regions are observed from Fig. 6a-6b (175)C^0, within the temperature range studied, while single glass transition temperature has been observed for PMMA/PVP blend. The melting point in the region 368–372K (shown in Fig. 6c-d) and 370–372K (Tg_1) corresponds to the melting point of PMMA and PVP blend. This corresponds to_Qabas Nawfal Mohsina, Mechanical and Thermal Properties of Poly (Methyl Methacrylate) Supported with Zirconium Oxide as a

Base Material for Dentures. *S*tudying the effect of weight ratios Selected (0.2, 0.5, 0.7,1, 3 and 5) to poly-methyl methacrylate resin (18).



5a 5b

5-C 5-d

Figure 5. Show Differential scanning calorimetric (DSC)

Toxicity Test

Through this examination, we were able to know the toxicity of the sample PMMA-PVP blend at a concentration of 22% PVP and 78% PMMA blend. Its note that the average survival rate is 100. We note that these values drop to 89.66 for the PMMA_PVP blend. This can be explained by the fact that the mixing process in this ratio led to the occurrence of more stable polymeric chains, and thus this result appeared and this appears in FTIR. These results are consistent with the global standards of the World Health Organization. This agree with- H. Wu, I.D. Wu (14). The figure (6) show the lost toxicity appear at 22% of PVP.

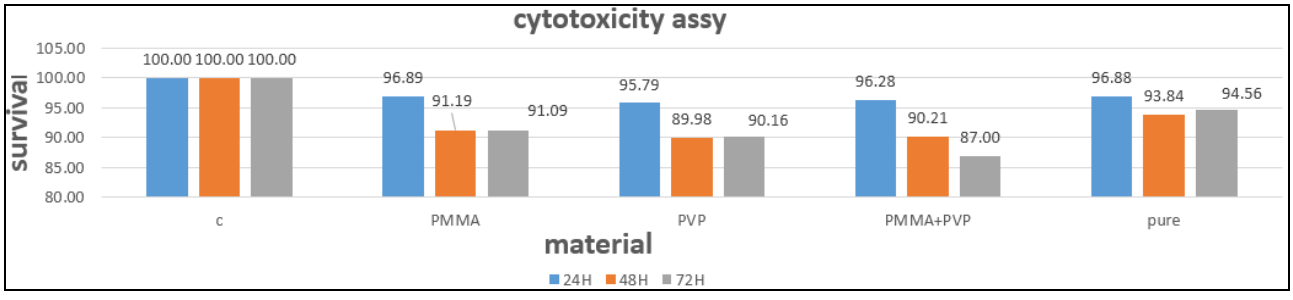


Fig. 6. Show relationship between survival and material

Conclusion

- Through the study of this experiment, we have concluded the following assumptions:
- The morphological study exploitation FE-SEM found that the blend particles size was between 37.33 nm-71.54 nm.
- From FTIR results appeared that every bond between polymer and blend particles are physical bonds this refers to the nature of blend.
- The PMMA-PVP blend take into account as bactericide materials against of streptococcus, additionally its non-toxic material.
- The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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