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Mechanical and thermal (Poly methyl methacrylate' / Poly Vinyl Pyrrolidone) blend use in denture material

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***Abstract*---**In the main search, efforts are made to develop the properties of the PMMA resin that is used: To create a blend polymer for the upper and lower prosthesis of a complete denture, several weight ratios of poly vinyl pyrrolidone (pvp) (0,2%, 6%, 10%, 14%, 18%, 22%, 26%) were added to cold-cured poly methyl methacrylate (PMMA). The effects of external polyvinylpyrrolidone (PVP) concentrations on mechanical features such as hardness, impact resistance, wear resistance, and thermal conductivity are studied. The results indicate that as concentrations were elevated, hardness, strength, impact resistance, and wear resistance increased, along with a decrease in thermal conductivity. The positive findings seem to have been (22% PVP and 78% PMMA).

***Keywords*---**PVP/PMMA, blend, mechanical properties, hardness strength, and wear resistance.

Introduction

The blending of various polymers is one of the most important "made from various materials" for making "more efficient and attractive" products for various applications [1-2]. Polymer blends are blends of two or more polymers that can either be fully incorporated at the molecular level or split into two phases. The morphology of the blended components is important because polymer blends show a unique combination of component properties [3–4]. The most common failure of prosthodontic denture-based materials, as well as the most common issue of denture base serving, is acrylic resin fracture, which is still an outstanding problem [5–6]. One analysis revealed that somewhere between 63%

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and 68% of complete denture prostheses deteriorated within a few years of being implanted. Fabre as a function of impact failure outside the mouth when the denture was accidentally put on a hard surface and incredibly low strength inside the mouth as a consequence of accurate occlusal biting force [7-8]. Combining the mechanical and physical properties of a material's component polymers can result in new materials [9]. Using the right mix of elements in the right ratio can improve the material's grade. New products with better physical, chemical, and mechanical properties were produced through the implementation of novel properties into polymer blends [10–11]. Two polymers with various characteristics are typically blended to create new synthetic polymers. Either of the two polymers' characteristics may be present in this unique polymeric material. The internal micro phase of a polymer blend greatly affects its toughness, strength, and other properties, or morphology [12].

The study's objective is to improve a PMMA/PVP blend's mechanical characteristics (impact, hardness, and wear resistance).

Experimental

1- The powder material that was pink in color and used in this work, provided by (Vertex-Dental Company), is polymethyl methacrylate (PMMA) cold-curing. The powdery resin is pink. SHADING at room temperature and adding liquid monomer to resin in a 1:2 ratio—1 g of liquid monomer to 2 g of particles results in a clear, drab fluid. Most of this material is defined by a soft feel, a low subatomic weight, a long pourable life, strong shading over a lengthy period, low shrinkage, and smooth polymerization.

2- Anhui Leaf hem Co., Ltd. in China makes polyvinylpyrrolidone, or PVP (mainland). is used as the second polymer in a cold-cure PMMA blend.

Preparation Specimens

ASTM tests. Weight percentage consisting of PVP powder. Two stages were used to prepare the sample. The first preparing pure sample for PMMA cold cure polymer by mixing an acrylic resin (PMMA) with monomer liquid (MMN) with ratio 2:1. (2from the powder and 1 from the liquid). To get the standard sample. The second stage was preparing of PMMA/pvp blend polymer samples by adding (2, 6, 10, 14, 18, 22 and 26) weight percent of pvp which mixed at room temperature for 20 minute and the use draped in the mold, prepared for machines samples (Impact, wear and hardness).

Figure(1-a) show impact sample

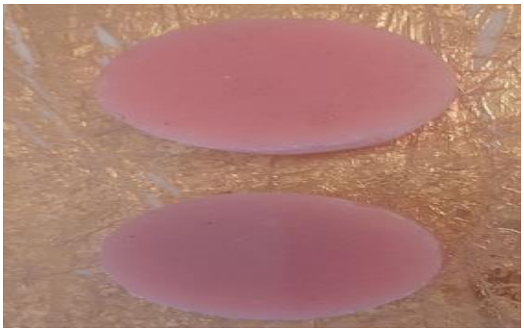

Figure (1-b) show hardness Sample

Mechanical Testing

In this study, hardness, impact strength, and wear resistance tests were done to evaluate the denture materials of a PMMA blend for their hardness, impact strength, and wear resistance properties. Studying a material's mechanical behavior is critical because it impacts how that material will react under stresses and settings. It may be used to assess a material's usefulness range and the service life that can be expected for a given application. used to classify and identify materials as well. Any material's mechanical factors change depending on the temperature, incorporating temperature, fast loading, and other variables.

Impact Test

Figure (2) shows the Charpy impact of a Poly Methacrylate/Poly Vinyl Pyrrolidone) blend with different PVP ratios (0, 2%, 6%, 10%, 14%, 18%, 22%, and 26%). From this figure, it can be seen that the impact strength increased in comparison to pure (PMMA) by increasing the weight ratio of (poly vinyl pyrrolidone) in the (PMMA/PVP) blend. After that, record the energy required to fracture the specimen, take an average for the results of the specimens tested, and determine the impact strength of these specimens. In Figure 2, the best mean impact strength at the concentration (PVP) is shown to be 22%. (PVP) covers the bulk of the space that is present at this concentration of (22%). This behavior is explained by the development of strong super-molecular security or cross-links between (PMMA) and (PVP) that shield along these lines the interface can move to constrain, which thusly leads to the high impact strength of the (PMMA) polymer to the plastic distortion through constricted development of the polymer chains along the stress direction by the (poly vinyl pyrrolidone) powder.

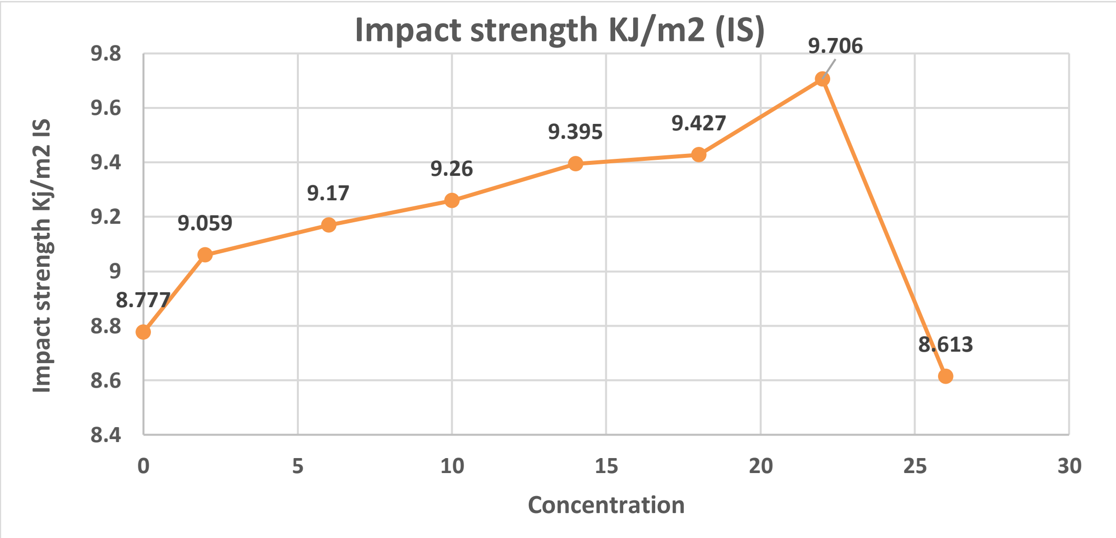

Figure (2) chart of mean values of impact strength test with different concentration.

Hardness Test

The results of a hardness test conducted for PMMA/PVP blends, specimens for the denture base materials used in this research, are shown in the figure as hardness strength values (3). which shows the effect of (PVP) concentration different (0, 2, 6, 10, 14 ,18 22 and 26) on the hardness strength of PMMA /PVP blend. From this Chart it can be noticed how the hardness strength values increased with the increasing of the weight ratios of PVP. This is due to the strengthening mechanisms which means that blend reduced the slippage of the PMMA blend. It can also be noticed that the addition of (PVP) has a noticeable effect on the hardness of PMMA /PVP blend specimens more than PMMA pure, therefore, hardness for (PMMA–PVP) blend is higher than the values of hardness for (PMMA) pure specimens. Thus, the hardness value increased from (80) for PMMA specimen (as referenced) to reach higher value of (91.5) for blend materials (PMMA 78%–22% PVP) chains by adding the spaces inside the PMMA polymer, but in (PMMA74%_ PVP26%) hardness loss because of the broken bond. The behavior was obtained in the PMMA /PVP blend by this is agree with the researchers, this agrees with Jasim B. S [16].

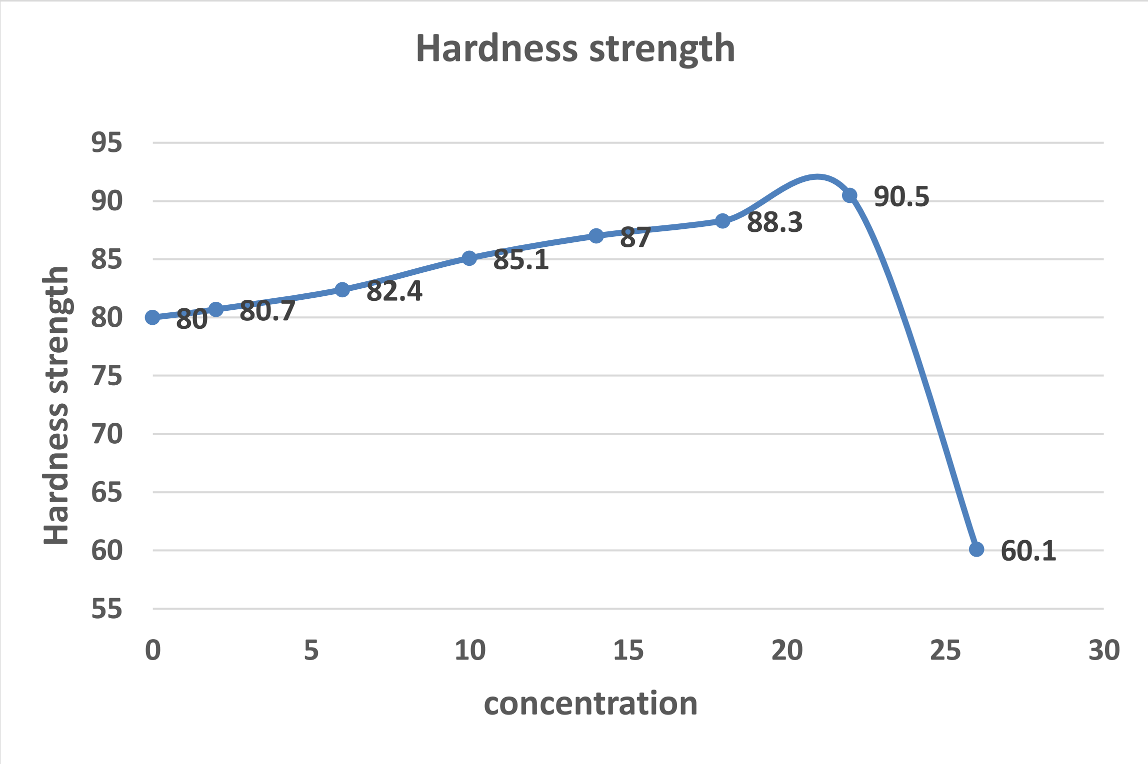

Figure (3) show relationship between hardness strength and concentration.

Wear Resistance

Figure (4) show of the wear with different concentration of (PMMA/PVP) blend with test time, the radius from the center of the sample to the center of the diameter and number of disk cycles constant. Figure [4] show decreases wear with increases of (PVP) concentration. The result shows an increase of (PVP) causes increase of hardness and stiffness which due to slow wear resistance. The best wear pear of (PMMA/PVP) blend ratio (78_22) equal 0, 3882*10 $^{-7}$ compared PMMA pure 1,826 *10 $^{-7}$. From this equation find wear ratio:

Wear Ratio = $\Delta W/\ S_D$ .... (1)

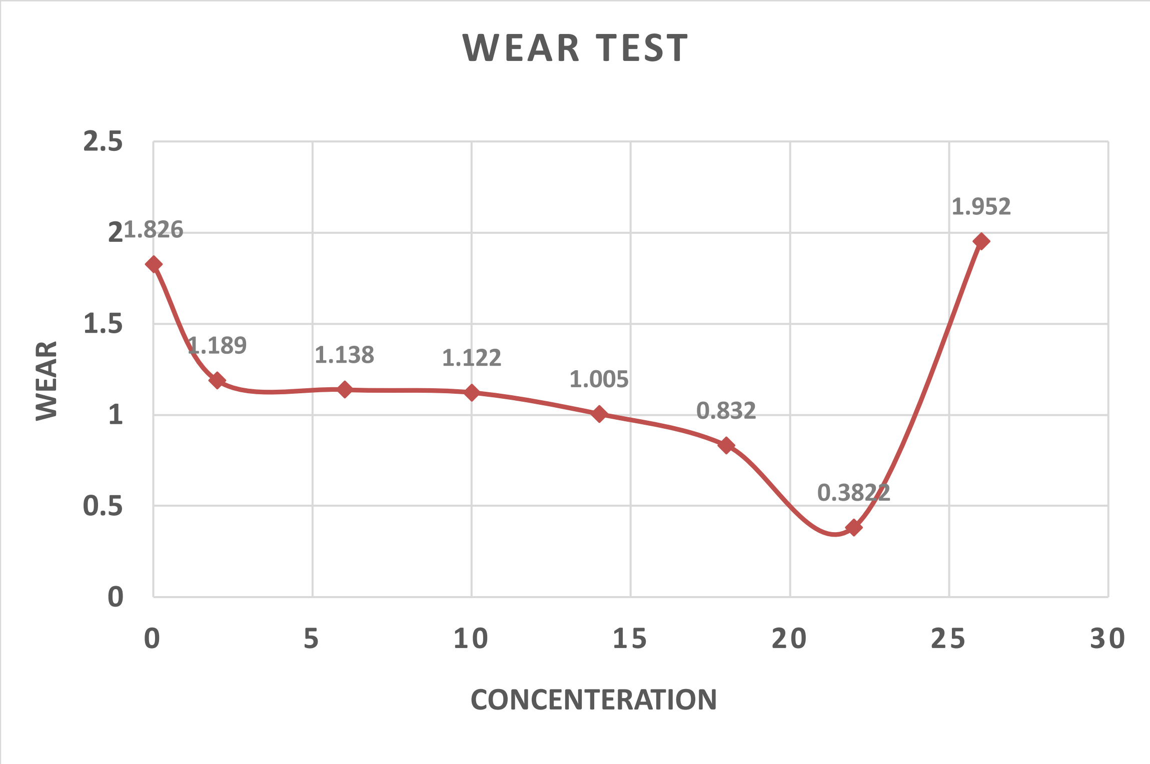

Figure (4) show the Relationship between wear and concentration.

Thermal Conductivity

The ability to transmit heat, or thermal conductivity, is one of the main thermal properties of dental materials. Its characteristics are obtained by subtracting the rate at which heat can be transmitted through a given cross-sectional area of material specimens during a given period of time (Powers and Sakaguchi, 2012). PMMA also shows poor thermal conductivity as compared to denture bases composed of gold or cobalt metals. That can be troublesome since it stops heat from becoming dissipated, which increases temperature and could lead to porosity during fabrication. The denture base material's thermal properties could have an effect on the palate's capacity to detect short changes in temperature. Figure (5) showed that the values of thermal conductivity were reduced with the addition of different amounts of PVP. S. T. Yaseen is in dispute with this (17). The breaking of the polymeric bonds within the blend causes the lowest value of thermal conductivity to appear at a concentration of 22%.

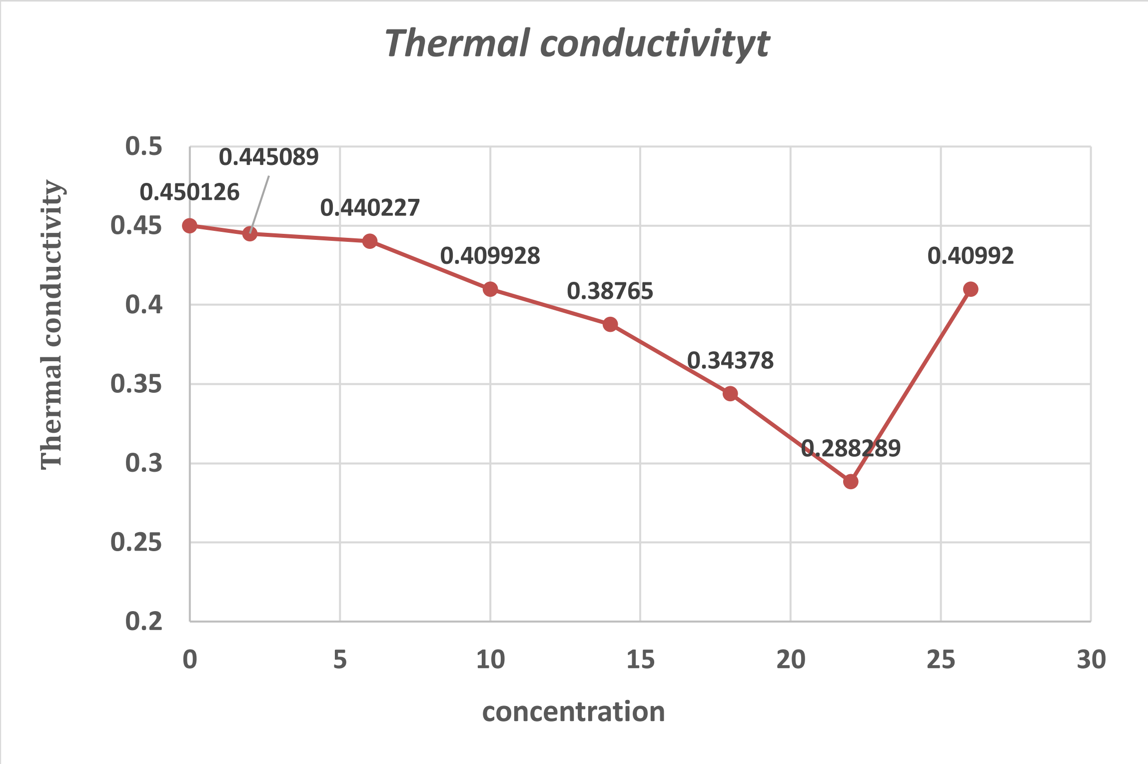

Figure (5) show relationship between thermal conductivity and concentration.

Conclusion

Hand blending is being used to construct PMMA/PVP blends. The samples include hardness, impact resistance, wear resistance, and thermal conductivity. With an increase in PVP concentration, properties like impact resistance, hardness, and wear resistance increase.

As PVP concentrations increase, the thermal conductivity tends to fall. The PVP ratio of the PMMA/PVP blend with the best results was 22.2%.

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