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Using the remnants of pomegranate peel particles to strengthen the bases of PMMA dentures

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***Abstract*---**Polymethylmethacrylate (PMMA) resin was used as a basic material in this research with pomegranate peel particles with fractional masses ((0,5,10,15 ,20%,25 ,30 %) as a cementing material with a granular size of 45µm)). Samples for mechanical tests to study mechanical properties (bending, shock, thermal conductivity) and at laboratory temperature (27°C(. The results of mechanical tests represented by (bending, shock) showed that the best value obtained for the bending modulus is (67Mpa) at a mass fracture of 10%. Moreover, the best value for the shock resistance is (58kJ/m2) at 20% mass fracture, and the thermal conductivity property decreases to the lowest value (0.71W/m.c°) due to the increased reinforcement with pomegranate peels.

***Keywords*---**PMMA, pomegranate shell, bending, shock resistance, thermal conductivity.

Introduction

The active role of engineering materials entering into many different industrial fields has attracted the attention of designers and engineers. So these materials were selected and manufactured using design and build structures that match the need, functionality, and ability to analyze their failures. Mechanical and structural engineering always seeks to create structures because of their durability, strength, and corrosion resistance, reflecting aesthetics [1]. Polymers have many advantages compared to other materials. This is mainly due to the unique combination of hydrogen and carbon atoms. This combination makes the polymer extremely versatile and durable to intense summer sunlight, very low

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temperatures in winter, and humidity in the rainy season [2]. The widespread use of plastics has led to serious environmental, economic, and social problems. Finding where to dispose of plastic items is a big challenge [3]. With this problem, biodegradable materials in the form of fibers, particles, or combinations as reinforcement materials in the polymeric matrix have increased since the last decade. Natural and fine fibers offer different advantages over other synthetic or conventional fibers. Natural tonics offer many technical and environmental benefits because they are easy to supply, low cost, easy to process, biodegradable, and environmentally friendly [4]. PMMA resin is one of the polymers with high strength and high melting points. It has many attractive properties, lightweight, high permeability, transparency, high resistance to chemicals, good insulating properties, improving fracture resistance, polymer hardness, low cost, durability, and good resistance.

Resistant to UV rays, weather, and most other environmental factors, PMMA is one of the safest plastics. PMMA is highly sustainable due to its durability as it can be recycled. It is unlikely to break easily [5]. Pomegranate peels have received increasing attention due to their scientifically proven healing properties such as antioxidant, antimicrobial, anticancer, anti-ulcer, and anti-inflammatory activities. Pomegranate peels are the waste resulting from manufacturing pomegranate food, as they represent (20-30%) of the total weight of the pomegranate. The pomegranate peel contains [6]. Environmental waste is a by-product of human activity. Some natural fibers are considered one of the wastes, known as a renewable energy source that can be recycled. It is considered a new generation of reinforcements for composite materials based on polymeric and other materials. The issue of developing composite materials by reinforcing them with natural fibers or other environmentally friendly materials instead of traditional industrial materials is an important topic recently due to the increase in environmental awareness to reduce environmental waste that can be used in some applications [7].

The aim of the research

- Studying the effect of pomegranate peel residues in strengthening the polymeric resin (PMM) used in dentures and the extent of its impact on humans because of its positive health effects.
- Studying some mechanical properties and thermal conductivity of pomegranate peel residues in order to reach better results.

Equipment and Materials

Base Material

Polymethyl methacrylate (PMMA) resin with cold-type hardener was used as the base material. It is a brittle and lightweight solid powder of light pink color with a melting point (320 F) and density (1.17-1.20 g/cm3). It is converted to a liquid state by adding a hardener, a transparent liquid to resin (PMMA) in a ratio (1-2 g) to increase The rate of solidification of samples. It is resistant to ultraviolet rays, weather, and most other environmental factors, safer.

Reinforcement Material

The strengthening materials are pomegranate peels (PS), cleaned and placed under the sun's rays. The seeds are milled well in a high-quality technical way to obtain particles with a granular size of approximately (45 μm) in weight ratios (0.5,10,15,20,25,30%).

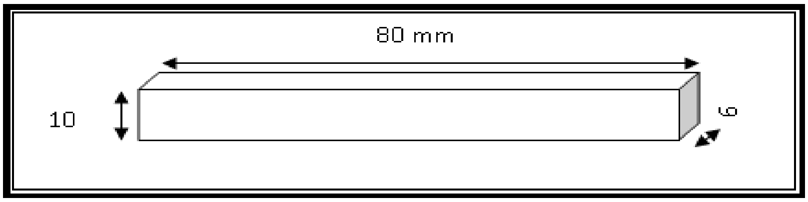
Sample Preparation

The method adopted in preparing the samples is the hand-lay-up molding method, where polished and defect-free aluminum molds were used according to international standards by weight ratios (0,5,10,15,20,25,30%) . The (PMMA) was mixed with the pomegranate peel gradually and slowly to achieve complete homogeneity between (PMMA) and the pomegranate peel. The mixing continues slowly so as not to create bubbles that affect the consistency of the prepared samples. The mixing is done in all directions to ensure uniformity ((3 min)). To avoid agglomeration in the mixture prepared for pouring in the special molds. After ensuring the proportion and absence of lumps and obtaining a suitable viscosity, the mixture is poured into the mold regularly and with high accuracy. Then, pouring the samples into the molds, they are left to solidify well for (10min) at room temperature. After the samples freeze, they are placed in an electric oven at a temperature of (50 °C) for (1 h) to get rid of the internal stresses to obtain the best crosslinking of the prepared samples' polymeric chains best hardening. Then the process is repeated with the same steps on all samples according to the weight ratios.

Mechanical Tests

Bending

After examination, Figure (3) is a bending test device. The bending samples were prepared according to the American Standard Specifications for Material Testing (ASTM D790) [8]. With dimensions of (4.8X10X100mm3), a three-point Bending Test was conducted for these samples, as the sample is fixed between the two armrests of the device, and then the load is placed in the middle of the sample until the moment of failure. Where the graph starts the reading of the test samples through which we get the (stress-strain) curves, and from those curves, we calculate (the bending strength). Figure (1) represents the standard dimensions diagram of the test samples for bending according to international standards)ASTM) The figure (2) represents the bending test samples before and after the examination and the figure (3) the bending test device



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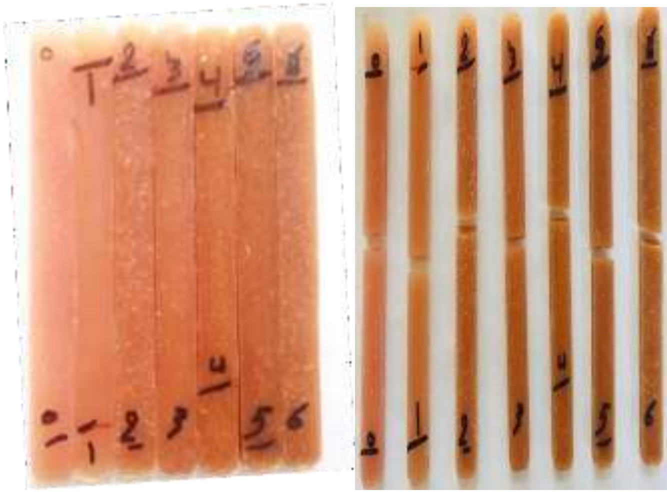

Figure (2) represents the bending test Test Apparatus

Figure (3) Bending before and after the examination

Shock Resistance

An Izod Charpy Tension Impact Test Instrument manufactured by Testing Machines, Inc, Amityville, New York, was used to examine all samples of the impact resistance test. The impact test samples were prepared according to the specifications, and the dimensions of the sample were (4 x 10 x 80 mm3) [9]. The sample to be examined is placed in the device and designated for it, and then the Impact Test device beeps. The pendulum is raised to the top of the device in the place designated to install it. After making sure that the sample, hammer, and pendulum are fixed, the test is started by releasing the pendulum from its upper position, so the potential energy in the pendulum is transformed into kinetic energy that collides with the samples for the test. This leads to breaking the sample by collision, and then we record the readings for the selection. Figure (4) represents the standard dimensions diagram of the shock test samples, Figure (5) represents the shock resistance test samples before and after the examination, and Figure (6) the shock test device.

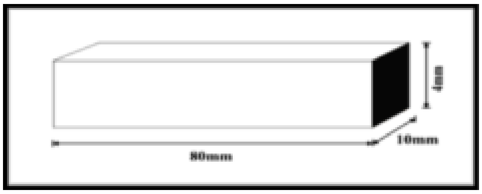

Figure (4) represents the standard dimensions

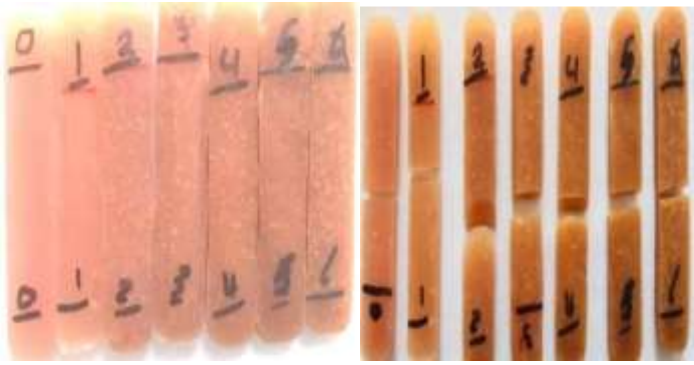

Figure (5) represents the shock resistance test samples before and after the examination

Figure (6) the shock test device

Thermal conductivity

In this test, Lee's disk device shown in Figures (10-3) manufactured by (Griffen & George) company was used to conduct the thermal conductivity test of the samples of the prepared materials and composites. It is possible to read the temperature of the three discs (TA, TB, TC) (°C) using the thermometers placed inside them, respectively. The heat is transferred from the heater to the next disc until it reaches the last disc. By knowing the radius of the discs (r) (mm), their thickness (ds) (mm) and the amount of current (I) of (0.25 Ampere) and a potential difference (V) of 6 Volt, the thermal conductivity can be calculated using the two equations [10].

$$K\left(\frac{T_B - T_A}{d_s}\right) = e\left[T_A + \frac{2}{r}\left(d_A + \frac{1}{4}d_s\right)T_A + \frac{1}{2r}d_s T_B\right]$$

$$H = IV = \pi r^2 e(T_A + T_B)\left[d_A T_A + d_s \frac{1}{2}(T_A + T_B) + d_B + T_B + d_c T_C\right]$$

Figure (7) represents the standard dimensions diagram of the test samples, and Figure (8) the thermal conductivity test device,and Figure (9) Thermal conductivity test samples before and after the examination

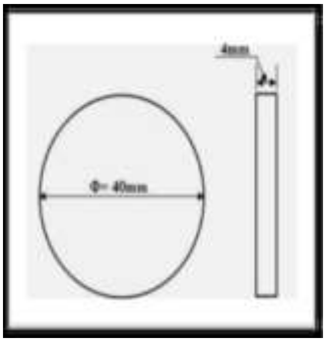

Figure (7) represents the standard dimensions diagram of the test samples

Figure (8) the thermal conductivity test device

Figure (9) Thermal conductivity test samples before and after the examination

Results and Discussion

Bending

Figure (10) shows that the values of bending strength when adding particles (PS) with Polymethyl Methacrylate (PMMA) resin reached the highest value by weight (10%) by (67 Mpa). The reason for this is the penetration of the particles into the content of the adhesive, which allows the fusion of those cracks with the particles and prevents the deformation from occurring in the adhesive material. Then the bending resistance gradually decreases as the weight ratios increase, which leads to failure due to the extent of linkability between the particles (PS) and the resin (PMMA).) [11].

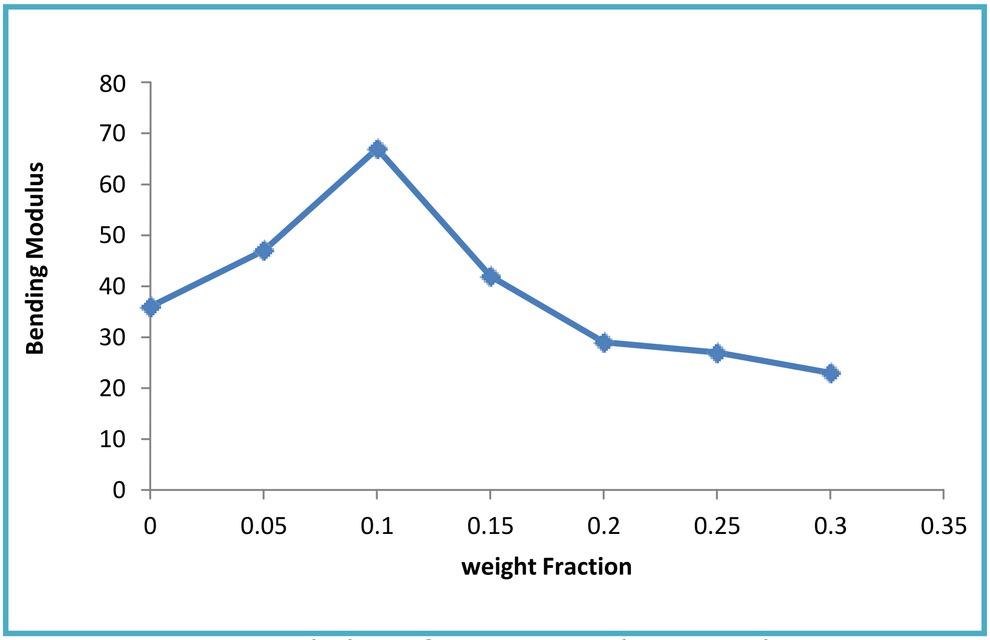

Figure (10) Bending Resistance(PMM + P S)

Shock

In Figure (11), the value of the shock resistance increases as the weight ratios of the particles (PS) increase. The highest value obtained at weight ratios (20%) amounted to (58 kJ/m2). This is because the particles bear the shock stresses of the material through the interface that moves from the adhesive material to the particles. The interface transmits the stresses to the materials used from those particles. It also works on dividing the effective kinetic load of the sample in addition to the optimal adhesive between the particles and the polymeric material. The high resistance of the polymeric material to the external stresses affecting it achieved a significant improvement in the mechanical properties, especially the shock resistance. This is also due to the nature of the beam, the polymeric chain, and the crosslinking that characterized the samples when the weight ratios of the prepared particles were increased [12].

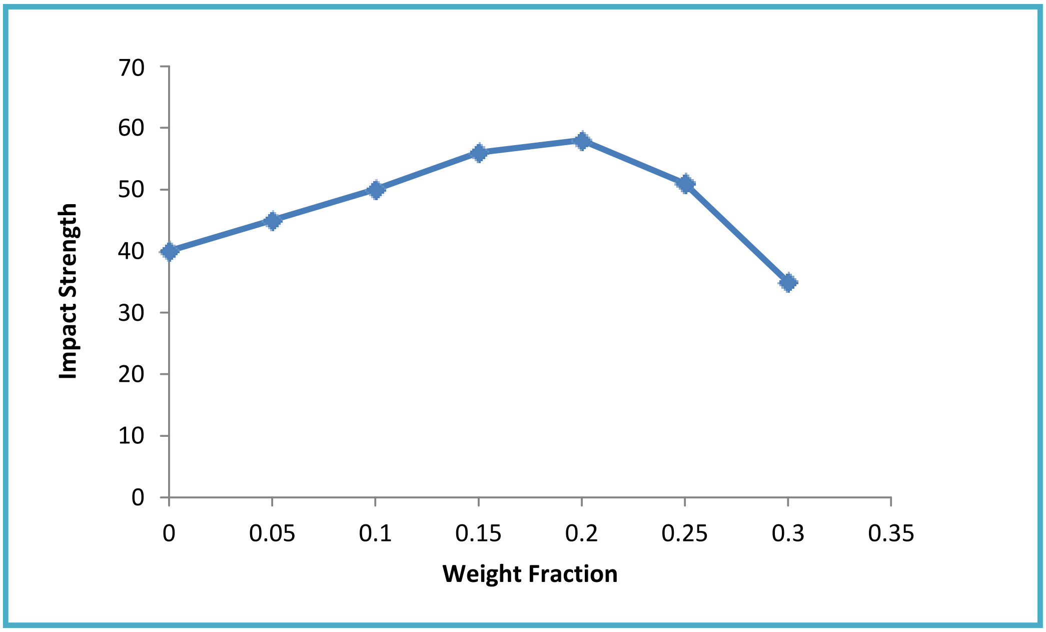

Figure (11) Shock Resistance(PMM + P S)

Thermal Conductivity

From Figure (12), a decrease in the thermal conductivity values of the composite material as the weight ratios of the pomegranate peel particles increased. This was characterized by a gradual decrease in thermal conductivity and was the lowest value at weight ratios (30%), amounting to (0.71) W/mc°. This decrease is due to the composite material's thermal conductivity being affected by the interface between the substrate and the supporting material and the irregular structure of the base material, which is made of heat-insulating polymeric materials with low thermal conductivity its heterogeneous random structure. This leads to a random dispersion of thermal energy when it is transmitted through the random structure of the polymer composite material. In addition to the presence of particles that are also randomly dispersed within the structure of the base material, which in turn leads to a random dispersal of thermal energy during its transmission through the random structure of the polymeric composite material, this leads to a decrease in the thermal conductivity of the prepared particulate composites [13].

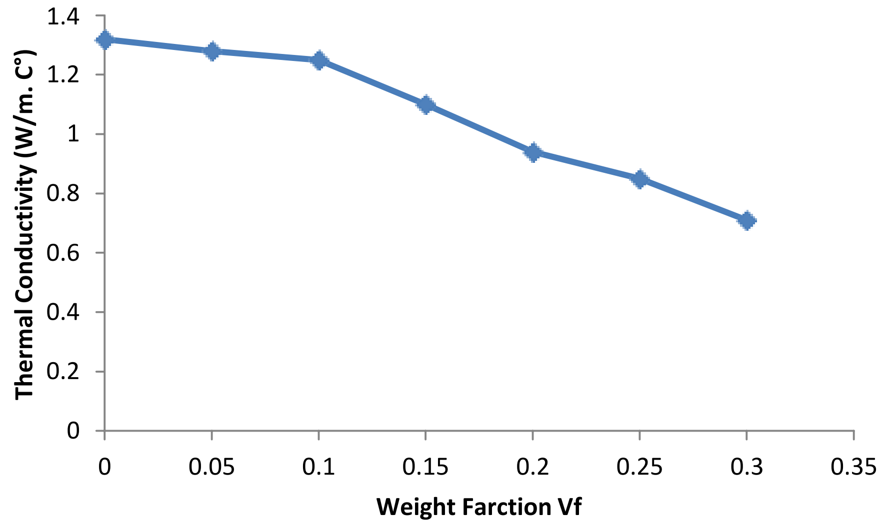

Figure (12) curve Thermal Conductivity(PMM + P S)

Conclusions

The use of quantities of pomegranate peels in proportions by weight with polymethyl methacrylate (PMMA) resin causes an increase in the mechanical properties (bending, shock resistance) of the overlapping materials the increase in the adhesion strength between the pomegranate peels. The best value for the curvature was (67 Gpa) at the percentage (10%). Furthermore, the best value for the shock resistance is (58 KJ/m^2) at the rate (20%) and a decrease in the physical property (thermal conductivity).

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