

Study the Addition Effect of Nano & Micro Titanium on the Mechanical Properties of PMMA Composites

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Abstract

The present paper focuses on the study of the mechanical properties of PMMA used in the preparation of dental molds has many problems. The purpose of this work is to eliminate as much as possible. Most of the problems caused by using polyethyl metha acrylate alone are the addition of titanium granules of different sizes. In act out to end a passable and identical direction of Ti sods in the polymer influence, mixer milling process was applied. The study is conducted in the preparation of samples of PMMA with micronized titanium granules at(0%, 0.5%, 1% , 1.5%), and other specimens of polymer are reinforced with titanium nanoparticles and in the same proportions. The tests are carried out to determine the validity of the composite material for use, the results are obtained from the tests of impact, and tensile testing where the specimens are reinforced with nanoparticles whose mechanical properties are (6 J/mm², 5.5MPa) the highest percentage of titanium nanoparticles, Corrosion rate decreased from(0.677 to 0.0015) a percentage (14.77%) ie give the highest and best results.

Keywords: PMMA, Nano Titanium, Mechanical Properties.

Introduction

In the course of recent years, another term has come to light and has turned into the focal point of the world's consideration The term "nanotechnology". Technology has produced a huge leap in all branches of science and engineering, as well as the medical, economic, electronic, computer, petrochemical, a Agricultural, biological, environmental, military and other applications [1, 2]. Although nanotechnology is relatively modern, the presence of devices containing structures with nanoscale measurements isn't new, and the way that the nearness of nanoparticles back to earth age and start Life in it; it is realized that the organic frameworks in the human body makes some exceptionally little gadgets, which reach up to The furthest reaches of the nano scale; living cells are an immaterial case of regular nanotechnology. The living cell is a typical archive for countless machines The manufacture proteins inside the cell in the form of combined lines, formed, "ribosomes" that are called nanoparticles. The enzymes themselves are a nanoparticle that stimulates chemical reactions depending on the need of the cell; thus, manufactured nanoparticles can interact within the cell and perform its various functions, such as analyzes. The contents of the cell, the delivery of the drug to it, or its destruction when it becomes harmful [3,4].

Regardless of the positive viewpoints that nanotechnology can continue from development and help of life, there are many who see that using this system in specific everyday issues may have unfortunate outcomes. Openings for work are relied upon to diminish in zones Traditional farming, production and the mechanical part thinking about the wide advancements in nanotechnology. Nanotechnology is the spot of man at work, it works quicker and with outrageous exactness. Nanoparticles are too little to even think about being That can empower access to the invulnerable arrangement of the human body. Nanoparticles can go through the layer of skin cells and lung, and what is all the more irritating is the capacity of these particles to break the cerebrum blood boundary [3, 4].

Although nanotechnology is generally present day, the nearness of gadgets Containing structures with nanoscale measurements isn't new, and the way that the nearness of nanoparticles back to earth age and start Life in it; it is realized that the organic frameworks in the human body fabricates some little gadgets, which reach up to The furthest reaches of the nano scale; living cells are an irrelevant case of regular nanotechnology. Despite the positive aspects that nanotechnology can sustain from the development and facilitation of life, there are many who see that The use of this technique in certain areas of life may have undesirable consequences. Job opportunities are expected to decrease in areas Traditional agriculture, manufacturing and the industrial sector; considering the wide developments in nanotechnology; Nanotechnology is the place of man at work. It works faster and with extreme precision, and nanoparticles are too small to be That can enable access to the immune system of the human body, and nanoparticles can pass through the membrane of skin cells And lung, and what is more disturbing is the ability of these particles to break the brain blood barrier; so here will be simplified definition of technology - Nano, its components, their relationship and their impact on the environment[3]

MATERIALS USED :-

Polymethyl Metha Acrylic Article Basis

This enrol includes samples of thankful-up dentures distance from polymer organization and reinforced titanium. The PMMA mix junior to the tell opiate hand-me-down in this counterfoil as a ground-breaking deterrent resin matrix, Castavaria, made from (Rubbish - Dental Company), for the preparation of samples from the base of the composite dental materials. Vertex™ Castavaria is a multifunctional self-polymerizing acrylic drift fundament be perfectly hand-me-down as a issuing, loose, repaired acrylic and repair acrylic. This brand of unfeeling has various escutcheon compared to modification tag of PMMA polymer such as:

exquisite sensible of, shabby molecular offset, durable color asylum, reasonably shrinkage, stable polymerization cycle with perfect end result, long porous acrylic and typical for long period of time But you crack multifarious unfavorable contribution such as: common encounter, camp hardness and more difficult while using fabrication [5].

Used Particles Reinforcement Materials

Cold-treated acrylic powder (Acropars, Marlic) and methyl methacrylate (Acropars, Marlic) are used to produce Polymethylmethacrylate (PMMA) as a polymeric base material for the compound [6]. In this study were used two types of Titanium particles as reinforces materials with volume fraction of (0%, 0.5%, 1% and 1.5%), the additions include the following: Despite titanium (Ti) alloys knowledge customer acceptance wanted qualifications such as antidote reaction behaviour, away history Jayhawker and stand fuselage, their low specific stiffness and wear resistance try on restricted their widespread application. Delayed, combination strategies have provided means for overcoming these limitations [7]

Table (1) Classification of the Groups of each Test.

Name of sample	Description
S1	Pure cold -cure acrylic resin (PMMA) .
S2	cold-cure acrylic resin (PMMA) with 0.5% Ti micro-fillers powder.
S3	cold-cure acrylic resin (PMMA) with 1% Ti micro-fillers powder.
S4	cold-cure acrylic resin (PMMA) with 1.5% Ti micro-fillers powder.
S5	cold-cure acrylic resin (PMMA) with 0.5% Ti nano-fillers powder.
S6	cold-cure acrylic resin (PMMA) with 1% Ti nano-fillers powder.
S7	cold-cure acrylic resin (PMMA) with 1.5% Ti nano-fillers powder.

Impact Test :

Shock resistance can be defined as the strength of the material to absorb energy. Shock resistance can also be used to measure the material's bearing load for shocks or external loads, since the base of the tooth kit is highly susceptible to breakage when accidentally dropped, Thus, the measurement of shock resistance is very important for the acrylate tooth base. This test was carried out at room temperature using the pendulum method. Lozd test samples were tested without incision according to international specifications[8]. The encounter obliged to retire from the specimens was suited using Equation (1) [9].

$$IS = \frac{EC(Kg \cdot mm)}{h \cdot bA} \quad (1)$$

Where:

- 1- "EC" is vitality consumed by breaking the test, "bA"
- 2- "IS" is impact strength in (kJ/mm²),
- 3-, and "h" is the specimens width.

Tensile Test :

The tensile test was performed by adding a force of 5 kN using the same tensile strength for all samples supported by micro and reinforced by nanoparticles. The samples were placed between the machine jaws. The force was applied until the fraction was removed from the center. The reading was taken for each test with a diagram showing the stages of breaking the specimens up to the maximum Possible tensile strength and all specimens [10].the Figure (1)shows the specimens used in tensile test.

Corrosion Test

Samples of polyethylmethacrylate were prepared without addition, and other samples were reinforced with nanoparticles (0.5%, 1% and 1.5%). The practical application of the research is the base of the artificial teeth. Therefore, the wear test solution will be prepared and pre-prepared saliva. In order to obtain the correct results, Including the temperature of the room and ventilation. The simple immersion method was used to measure the corrosion rate for all samples and temperature of 27 degrees Celsius for the duration of immersion was measured by day and for two weeks.The samples were prepared by hand casting in an iron mold with a dimension(3.3*21*25) mm [11]. The samples were sampled for suspension. Each specimens was immersed in a solution of 100 mm of saliva after the samples were weighed before immersion in order to determine the change in weight [12].

Specimens Preparation:

The PMMA denture base materials comprise polymer powder and monomer fluid (methyl methacrylate, MMA). The virus fix acrylic tar type (Castavaria), was utilized to set up the PMMA composite examples. The standard extent in blending proportion for virus fix (self-fix) acrylic tar is more often than not around (2 g) polymer powder (PMMA) and (0.97 g) monomer fluid (MMA) (2 g/0. 97g) by weight as indicated by the producer's directions of maker organization. When blending powder and fluid numerous progressions will happen because of arrangement of polymer in the monomer[13]. This proportion was impact on the usefulness of the blend, dimensional changes and poisonous quality of acrylic gum examples [14]. The titanium is added to the poly methyl methacrylate by percentages (0%, 0.5%, 1%, 1.5%) show the figure (1). Mix well and add the liquid to the mixture to obtain different pastries and pour into moving wooden molds according to the samples required for each test The standard dimensions were used as manual casting method.

Results and Discussion

Impact Test :

The addition of titanium has a clear effect in reducing the impact resistance of the composite material, because titanium is a fragile material that reduces the strength of the base material, but the addition of titanium nanometer size gives better properties as shown in the figure (1)and table(1),(2) The reasons for this conduct are identified with the awful dissemination of nanoparticles, particularly in the High level of added substances

to nanoparticles for nano-composite materials This will prompt the biggest aggregation of nanoparticles that may prompt Increase the convergence of weight in composite materials close nanoparticles Such stresses are sufficient to break the interface's cooperations and make de Bonding between PMMA powders and nanoparticles is why the cracks spread faster Within the material so that the fracture occurs immediately [15] Besides, the elasticity limit (hardness) of the material due to Add nanocrystalline particles that reduce matrix distortion by Restrict the kinetics of grid chains and furthermore, high convergences of Nanoparticles lead to a decrease in the capacity of the PMMA framework to retain vitality, consequently ,Decreasing durability,[16]. so that the force of impact decreases show figure (2) [17, 2].

Tensile Test:

Significant physical properties of acrylic saps are demonstrated to be impacted by the expansion of Ti nanoparticles as the fortification operators. Lately, metal nanoparticles have been to a great extent researched for their movement as antimicrobial add-tives. Specifically, Ti is presently viewed as an ease, clean photocatalyst with concoction solidness and non-harmfulness, and has been utilized for a wide assortment of natural applications, including water treat-ment and air purification.26,27 Acosta-Torre et al28 revealed that the presentation of nano-sized metal oxide materials for getting ready acrylic saps permits the generation of polymer with both shading and sur-face adjustments. As indicated by the last investigation, physical properties of nanopigmented and standard PMMA demonstrated a lower porosity for Ti containing PMMA table (2) and table(3) show the change of mechanical properties with the Volume Fraction (%).Figure (2) ,(3) shows that nanoparticle-reinforced specimens are denoted faster and with less effort compared to macromolecular specimens. This is due to the random arrangement and the unorganized mass of nanoparticles leading to increased stress in place at the expense of the other, which in turn increases cracking The specimens are broken with minimal stress as well as having a titanium element that clears the brittle. [15, 16 ,2].

Corrosion Test:

Calculate the rate of corrosion using the following equation:

$$CR = \frac{\Delta W}{A} \dots \dots \dots equ (2)$$

CR=corrosion rate .

ΔW = The amount of change in weight.

A =area of specimens

and the grading rate in g / mm 2. The nanoparticle reinforced samples lowered the corrosion rate by increasing the strength of the particles and the same samples in the small titanium. However, corrosion resistance is better with nanoparticles-reinforced samples. Corrosion resistance is better with titanium-supported samples. This is due to the belief that the addition of titanium ,a corrosion-resistant element and its presence, increases the corrosion resistance of the base material. The other reason is that the size of the nanoparticles is very small and this means an increase in the surface area, that is, the cathode area is larger, leading to reduced erosion and corrosion cells, reducing the area of the anode, which in turn increases resistance to erosion show the figure (4)

Conclusions :-

After conducting astude on specimens prepared for the mold base of the artificial teeth kit,the researcher comes up with the following conclusions :

- 1- Some mechanical properties (impact resistance and tensile strength) of composite material decrease and decrease by increasing the proportion of the addition of titanium and increasing the fragility of the material.
- 2-One of the findings is that the addition of nano titanium improves mechanical properties better than micro titanium .

3- The results also indicate that the corrosion rate decreases with the increase of nano-titanium over time, which in turn improves corrosion resistance.

Table(2) The Mechanical Properties of Polyethyl Methacrylate Reinforced by Titanium nanoparticle:

Mechanical properties	1.5%Ti	1%Ti	0.5% Ti	0% Ti
Tensile (MPa)	4	6	17	20
Impact(J/mm ²)	5.5	6.4	7.3	1.3

Table(3) The Mechanical Properties of Polyethyl Methacrylate Reinforced by Titanium Micro :

Mechanical properties	1.5%Ti	1%Ti	0.5% Ti	0% Ti
Tensile (MPa)	14	4	12	20
Impact(J/mm ²)	9.1	6.4	4.5	1.3

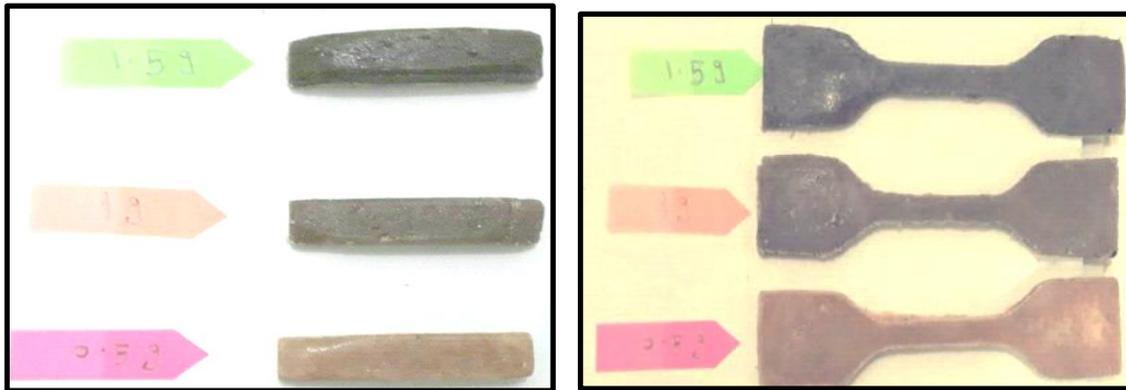


Figure (1) the samples of tensile and impact test

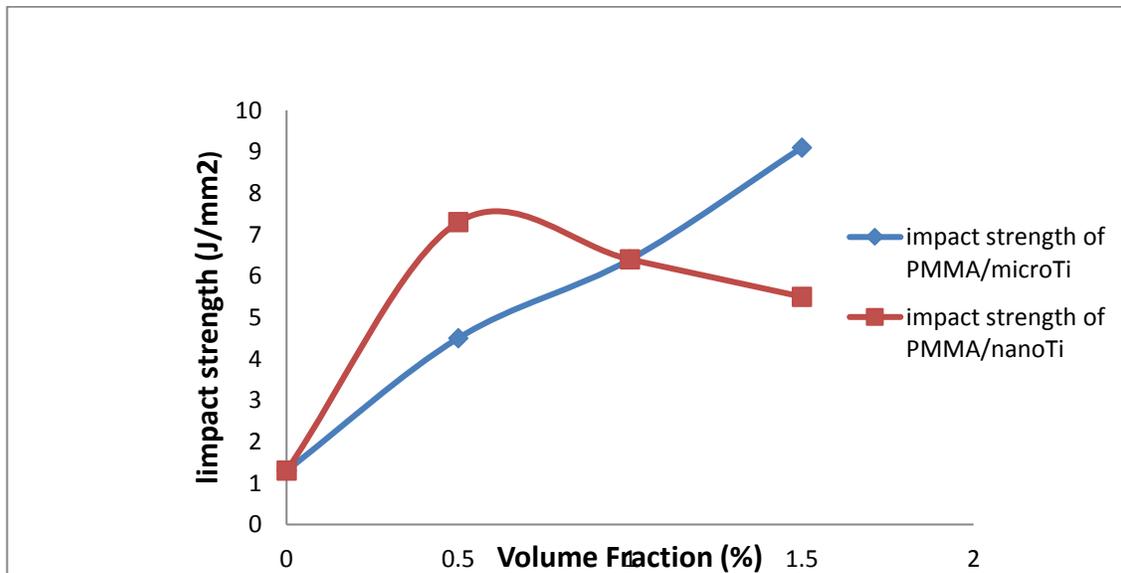


Figure (2) a comparison between samples supported by nanoparticles and micronutrient-reinforced samples in the impact test

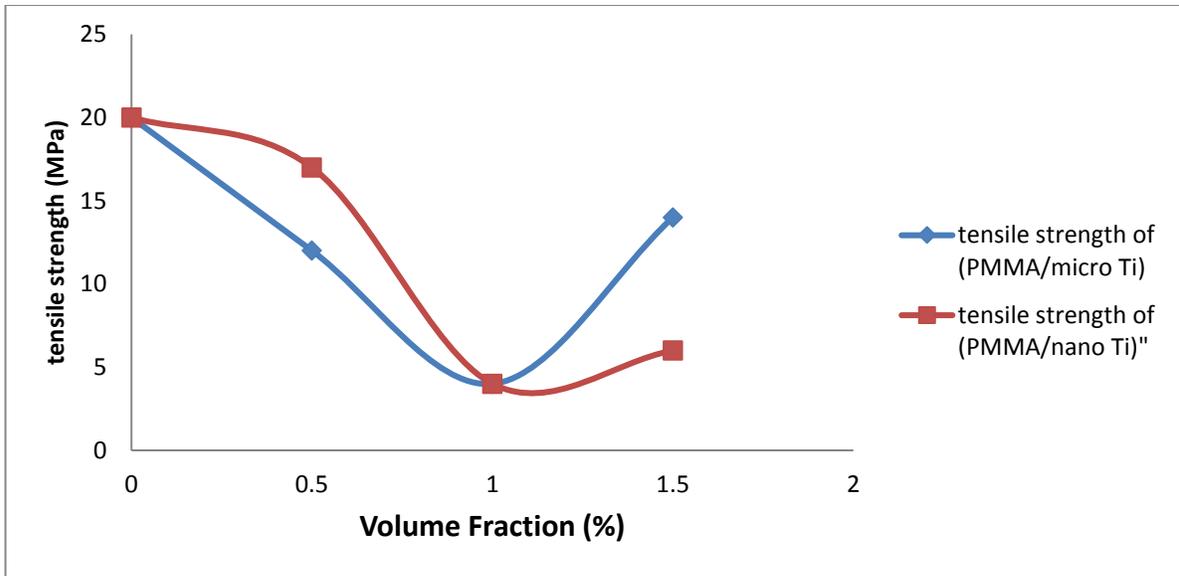


Figure (3) a comparison between samples supported by nanoparticles and micronutrient-reinforced samples in the tensile test

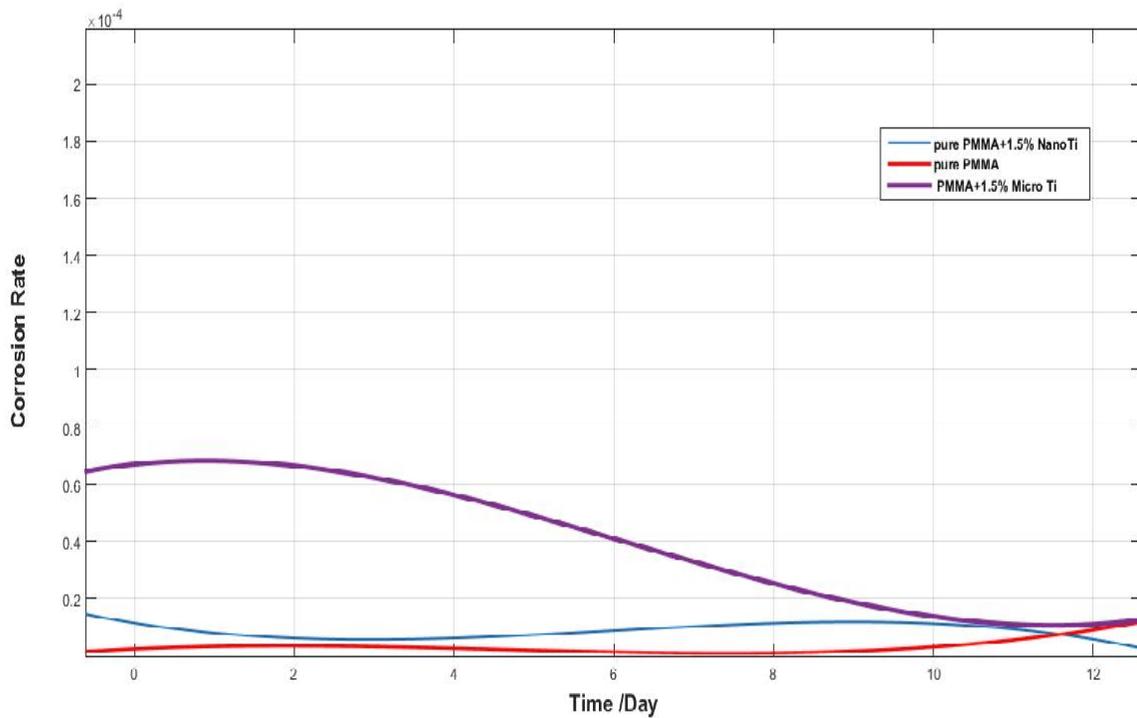


Figure (4) a comparison between samples supported by nanoparticles and micronutrient-reinforced samples in the corrosion test

Conflicts of Interest

The author declares that they have no conflicts of interest.

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دراسة تأثير اضافة حبيبات النانو Ti & المايكرو Ti على الخواص الميكانيكية لـ PMMA

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الخلاصة:

ركزت الدراسة على دراسة الخواص الميكانيكية للـ PMMA المستخدمة في تحضير قوالب الأسنان لديها العديد من المشكلات. والغرض من هذا العمل هو القضاء على أكبر قدر ممكن. معظم المشاكل الناجمة عن استخدام البولي ايثيل ميثا اكريليت وحدها هي إضافة حبيبات التيتانيوم من مختلف الأحجام. في العمل لإنهاء اتجاه مقبول ومماثل لأحماض Ti في تأثير البوليمر ، تم تطبيق عملية طحن الخلاط. وقد أجريت الدراسة في تحضير عينات من PMMA مع حبيبات التيتانيوم المجهرية في (0 % ، 0.5 % ، 1 % ، 1.5 %) ، وعينات أخرى من البوليمر معززة بجزيئات التيتانيوم النانوية وبنفس النسب. تم إجراء الاختبارات في مرحلة الإعداد المسبق لتحديد صلاحية المادة المركبة للاستخدام، والنتائج التي تم الحصول عليها من اختبارات التصادم، واختبار الشد حيث تم تعزيز العينات بجزيئات جزيئية متناهية الصغر تكون خواصها الميكانيكية (6 / mm²، 5.5MPa) أعلى نسبة من جسيمات التيتانيوم النانوية، انخفض معدل التآكل من (0.677 إلى 0.0015) ونسبة (14.77%) أي إعطاء أعلى النتائج وأفضلها.

الكلمات الدالة: PMMA ، نانو تيتانيوم، الخواص الميكانيكية.