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Mechanical Investigation of Dental Fillings Polymethylmethacrylate-$ZnTiO_3$

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In this work, developed dental fillings PMMA supported by Bio-nanoceramic-$ZnTiO_3$ were prepared by effective mechanic mixture, four different amount of $ZnTiO_3$ nano particles (1%, 3%, 5%, 7% wt), Respectively was mixed in base-material achieved by mixing fluid and Ultrasound to prepare nanocomposite in the figure of industrial fillings, Samples were constituted to looking into mechanical properties acceptable SI Units. Moreover, Vickers micro hardness measurements of PMMA-$ZnTiO_3$ were performed, and improvement perfectly clear compare base material (PMMA). Impact stress was examined using devise (Charpy). The results show increased in the ratio (1%, 3%, 5%) and few breakdown in 7%. All Samples appear high resistance of fracture compare with base material. All samples exhibited refinement Compressive, bending Strength when evaluated by (Universal machine) and Young Coefficient SEM micrographs were in agreement with the results obtained during mechanical characterization by appearance distribution $ZnTiO_3$ through base material of ductile tearing pattern which is associated with plastic deformation.

Keywords: Dental Fillings, Bio-Nanoceramic, $ZnTiO_3$, PMMA, Nanocomposite.

1. INTRODUCTION

PMMA based materials are widely used as biomaterials [1]. The resin polymer "PMMA" its more used resin for teeth and bone base synthesis. This resin possesses satisfactory mechanical, physical, and aesthetic characteristics [2]. It has also been the chemical model for many material developments in dentistry such as restorative materials and in-solubility in any fluids, relative ease of manipulation, good aesthetic appearance and color stability [3]. However, disadvantages of PMMA are poor sol- vent resistance low continuous use temperature of approx. 500 c (1200 F). Poor fatigue resistance notch sensitive [4]. The side effects of the polymer "PMMA" application are biomaterials with tissue at the "cement interface" due to the crasser of heat during the "polymerization reaction". Therefore, research is being carried out in the development of bone- cement with new class composites. The aim was to development a new nano-composits cement that would have low setting heat capacity and good mechanical strength and be bio-comparable with the available once [5]. To enhancement the properties of

Any polymer, its more can be used, one of them type of fillers. The nano- composite materials will use in viewable applications. The composite base polymer matrices have been gated with different structural and shape nano-fillers [9]. Nano- filler are used to improvement the properties of the resin polymer materials .Titanium Oxide and zinc oxide have been used as fillers. In 20th century Titanium Dioxide and bio- ceramic has been used as a biomaterials, ointments, toothpaste etc. [10]. The mixture of first sample PMMA and in the turning round of 50 gm by 0.001 g. The second sample consists of "PMMA/ TiO_2 in the ratio by weight. After mixing and characterization we have been found PMMA/GO/TiO_2 has shown better hardness and elastic properties which is good for dental application. The effects of clay surface modification, loading and solvent nature on the thermal properties of bioceramic /PMMA nanocomposites obtained by *in situ* photo polymerization were investigated. In comparison with pure PMMA, glass transition temperature and storage modulus

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of resin polymer materials are notably improved by the presence of ceramic . It is worth pointing that the increase in potential modulus of nano-composites con- firms loads resistance of materials against base matrix [7].

Composites materials contain a range of additions including glass ceramic , quartz and advance fillers particles based on the oxides .The Nano-fillers is their increase the load of the inter-phase. Micro- addatio composites have a high filler load compared to for the nanofilled [8]. Some very promising nanoparticles (NPs) that can be used to modify the bio- material for denture bases are zinc oxide \ NPs. The study of the bio-thin de-position on the surface showed that anti-fungal properties increase with increasing load fillers. A nano-composite revealed the lowest load of Candida. in conjunction with testing the turbidity of solvint, may explained the mechanism "ZnO- NPs" exert their effect on the load increased induction of ant oxidative reinforced in micro-organism cells. The increased synthesis of reactive oxygen can cause fungicidal action where anti-fungal properties of "ZnO- PMMA" nano-composites, were demonstrated and the fact that they increase with increasing content of these zinc oxide nanoparticles was highlighted [9]. Ther are large field of nano- fillers, such as "SiO_2", "ZrO_2, TiO_2, Al_2O_3, $BaSO_4$, HA, Ag, " , have been used in teeth composites. The results of the more review explained that the thrmo-mechanical and strength properties of teeth and bone nano-composites with lower filler are superior to micro-filled "dental composites". The inter- effects of nano-particles strongly depend on many coeffecient, such as the type and co-mechanical properties of nano-fillers, uniform dispersal of nano-fillers within the resin polymer bases,

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Volume fraction of the filler nano-particles, and variables' of [11].

The current study aimed to investigate the effect of the addition of nano-ZrO_2 on the translucency and tensile properties of the PMMA denture base material. The results found that all experimental groups showed increased tensile strength in direct proportion to the concentrations of nano-ZrO_2, but the translucency decreased; therefore, the hypothesis of this study was accepted [12]. The addition of "zinc oxide" to bio-active ceramic glasses has a great influence in enhancement the "mechanical" "physical" "structural", and bio- logical properties of the bio-active ceramic glass. De-pending on the percentage in which "ZnO.

Glass ceramic compositions, "ZnO" acts either as a as an inter-mediate oxide. The presence of ZnO in the glass structure controls the overall leaching behaviour of the silicate matrix having consequently an effect on the glass surface reactivity in contact with physiological flu- ids. The influence of zinc on the properties of bio-active glasses ceramic no depends on the "zinc oxide " content but also of the other oxides [13].

2. THEORY PART

2.1. Vickers Micro Hardness

The Vickers micro-hardness diamond load pyramid as the inde-nter. (Fig. 1). Because of the shape of the indenter, the test is often called the "diamond- pyramid hardness test". "Vickers hardness number" is defined as the load divided by the (surface – area) of the inden-tation. In practice, the indentation area is calculated from the micro-scopic measurements of the lengths of the Dia-gonals of the im-pression [14].

The Vickers hardness number using the following equation:

$$(1)\ Hv = 1.854\ (P/d2) \quad (1)$$

$P =$ Load N

$d2 =$ Impact diameter [15].

2.2. Bending Strength

The flexural stress is defined as the maximum uni-axial. The test is conducted with the same type of universal method testing machine used for "tensile" and "compressive" strength measurements [16]. The Flexural strength is:

$$Y = o/\epsilon \quad (2)$$

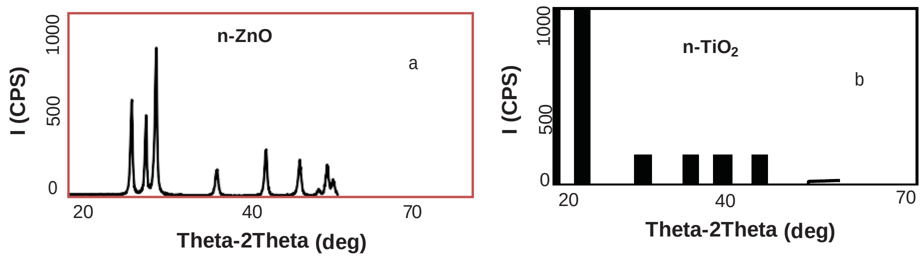

Fig. 1. X-ray diffraction of (a) n-ZnO and (b) n-TiO_2.

Young's Modulus Pa
Where

$$E = mgl3/48IS \quad (3)$$

$I =$ length, $S =$ deflection

$$I = bd3/12 \quad (4)$$

$I =$ moment of Inertia [17].

2.3. Impact Strength

Impact testing is of enormous importance. A collision between two objects can often result in damage to one or both of them. The damage might be a scratch, crack, fracture or break. Scientists need to know about how materials and products behave under impact and the magnitude of forces they can resist. How well something resists damage is called its impact resistance. An impact test measures how much energy is absorbed when an object fractures or breaks under a high speed collision. It's an important property. The safety of many consumer products depends on their resistance to breaking. But impact resistance is difficult to quantify [18].
(1) Impact Strength IS

$$I.S = E/A \text{ KJ/m}^2$$

$E =$Energy of fracture (KJ) and $A = b * d =$cross sectional (m^2) [19].

2.4. Compressive Strength

Its compressive strength is an important aspect in deciding its load carrying capacity. Normally, it is determined by casting and testing of concrete specimens in the laboratory. In its service life, many situations may arise wherein measurement and analysis of structural integrity and other properties of concrete structures have to be carried out. Many of the existing methods for the assessment of concrete strength are destructive in nature. The compressive strength of hardened concrete is, generally, determined by destructive testing of control specimens in a Compression Testing Machine (CTM) in the laboratory. However, a direct correlation never existed between the compressive strength of hardened concrete obtained by testing of representative specimens like cubes or cylinders and that available in structures [20, 21]. The Compressive Strength MPa

$$ç = P/A - \text{MPa}$$

3. EXPERIMENTAL AND MATERIALS USED

3.1. Material

In this project, polymethylmethacrylate (PMMA) was used with the solvent chloroform (indian) with ratio (3:5) and nano compound (ZnO, TiO_2) about ratio (43–55 nano). At first, bio-nanoceramic-$ZnTiO_3$ was prepared by effective mixture with ratio (1:1), this method was defined by using many ball to mix powder in vial made of from alumina or zerconia. The mixed in the rate of (20 ball) for (10 g) powder and (350) cycle in minutes dry mix all
this work done by using (ball milling). To obtain bio-nanoceramic for pure biological properties using caloric treatment in (900 degree) as shown in Figure 1 appear X-ray diffraction. Many weight ratio to support bio-nanoceramic powder for polymer as substrate was applied by liquid mix and ultrasound technique. After that the sample intended for examination prepared under international stander condition.

4. RESULTS AND DISSECTION

The important investigation of mechanical properties in this project essentiality application in medical especially in bone reparation and dentistry. Many examination done about durability and strength of material for outwardly strees example scratch resist, flexile strength, impact strength and compressive strength as shown in Figures 1–5. The result of this project.

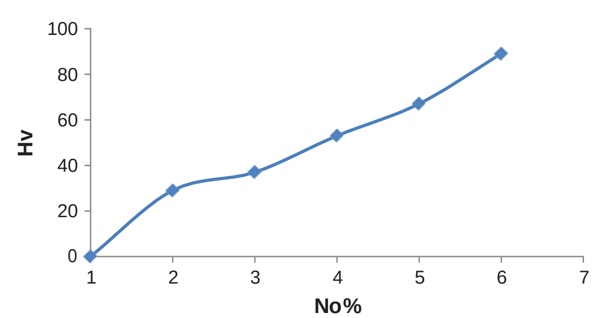

Fig. 2. Experimental values of micro hardness.

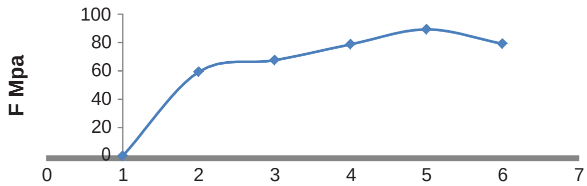

Fig. 3. Experimental values of flexural strength.

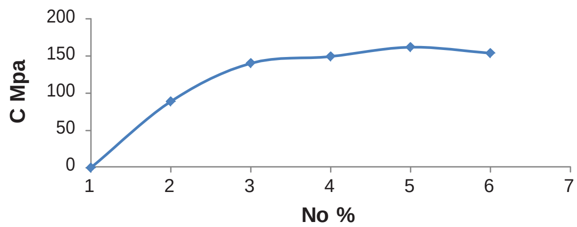

Fig. 4. Experimental values of compassion strength.

First, Figure 2 appears account of hardness and improvement for resistance of scratch display, also that increase hardness whenever increase rate of ceramic powder $ZnTiO_3$ compare base material (PMMA), the relationship between rate of additive with number of hardness is direct because ceramic powder have good hardness sequel homogenous diffusion and regular distribution within base material.

Second, Figure 3 shown result of dending strength. We can see addition resistance of bend and durability barrier 5% ceramic powder such as regular distribution, homogenues diffusion given strength for base material and could afforded bend rate at less 7%. This submit from other research that the high rate of nanomaterial verity low of some properties.

In Figure 4 was represent strength of material use instead of bone or dentistry to external pressure. The increase of amount nanoceramic result to increase resist sample for pressure compare base material rate 5% at the the same reason this is show in Ref. [22]. Figure 5 display impact strength for broken, and also can notes sequent increase of nanomaterial especially (5%). This means conglomerate and pools in specifics places when prepare sample because high surface area in ceramic-material at nano scale. This makes diffusion and distribution more than (5%) very difficult, but, in rate (7%) properties start

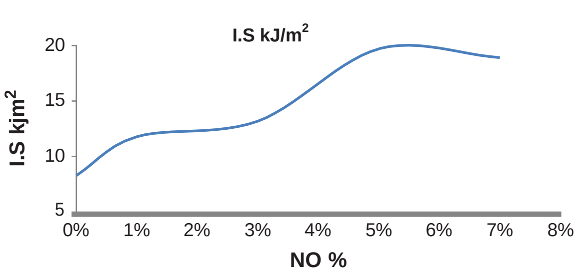

Fig. 5. Experimental values of impact strength.

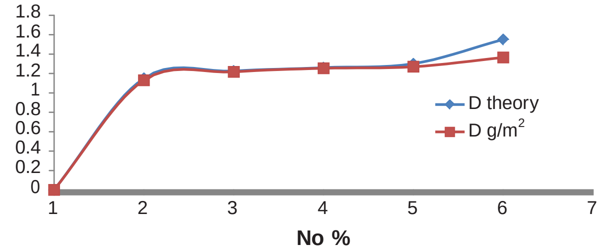

Fig. 6. Experimental and theoretical values of density.

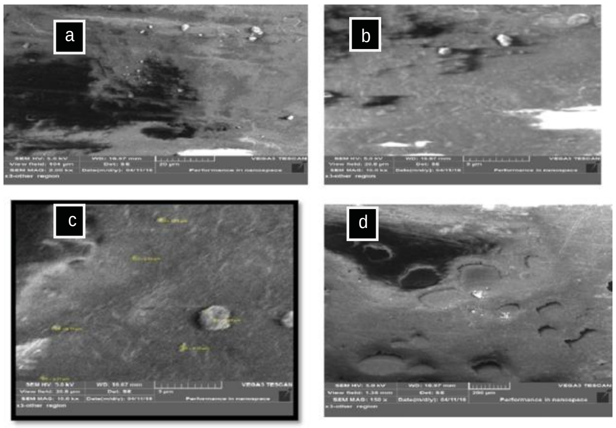

Fig. 7. Images of SEM: (a) 1% $ZnTiO_3$, (b) 3% $ZnTiO_3$, (c) 5% $ZnTiO_3$ and (d) 7% $ZnTiO_3$.

recede. Figure 6 explain values of density which matching so far experimental and theoretical values of density in rate (5%). This can also be seen in scanning electron microscopy (SEM) in Figure 7.

5. CONCLUSIONS

From the project of the mechanical properties, it can be concluded following:

Improvement all sample in the mechanical properties when addition bio-ceramic powder in the rate of (5%), where the rate of sensitivity to more (85%) compare base material.

Through compare measured particular density values with particular mechanical properties values for all samples, the result refers to that the samples supported by bioceramic powder could bearing high stress and resist broken. For that, this materials became promising compensative material and relevance for human body because lightness weight and high mechanical properties.

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