Studying the Effect of Zirconia on Some Physical Properties of Porcelain

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Abstract

In this study porcelain was prepared by using composition consisting of raw materials with in following fractions , 50% kaolin , 25% feldspar, and 25% silica(SiO_2) tested by X-Ray diffraction (XRD) method .Study the effect additives at different concentration from zirconia (ZrO_2) (2,5,10,15,20) Wt% on some physical properties of porcelain, the sample is prepared by the conventional manufacturing method , It is found that some physical properties of porcelain changes considerably with the substituent sample, It was found that the increase of zrconia (ZrO_2) additive of all our sample produce. Increasing in dielectric constant and bulk density and decreasing with open porosity and dielectric loss tangent.

Key words: Porcelain, Feldspar, ZrO_2 , dielectric constant , loss tangent.

Introduction

Porcelain is the one of the important kinds of the traditional material ceramic purest that occupied much more area in different fields.

It was made of mixture of the various burin white of clays fluxes of nature and in such properties, as would produce a dens body, It has been a good resistant to anenviran metal conditions [1], porcelain had been classified into two kinds, hard and true porcelain, it has higher thermal resistance shocking, it is makes a suitable electric industries as insurable. The two types are called soft porcelain, that consist of a complex compound of glass and little of clay [2, and 3]

The zirconium (Zr) material never occurs at pure states in nature, but can be found in many conjunctions with silicate oxide and has a compound zircon (ZrO_2 X SiO_2) and as freely oxide (ZrO_2) in the mineral name B[4] .

The mineral (ZrO_2) can't be used as primary material in density as a results of impurities for the different metals elements , it is defected that the color and radionudide nature like uremia that make the radioactive [5] , Fadhil A. et.al study the effect of magnesia addition and sintering of temperature and properties of synthesized electrical of porcelain [6] , it was shown that when the additive of MgO and sintering temperature increase in the bulk lead to increase of density, microhardned and the constant of dielectric constant.

Zahade et al have studied the alkaline oxide effective on the composition of porcelain, porosity, firing shrinking, strength and density, on the other hands [7].

Al- Bermanyet et al studied the influence of ZrO_2 , TiO_2 and ZnO on the mechanical properties for the porcelain , they showed that addition of ZnO , ZrO_2 and TiO_2 materials made composite .give a good medium for transiting ultrasound waving , so as they could be used as a coated material for the enhancement the coefficient absorption of porcelain [8].

Goztip campus studied the effect of nature of Zealot addition on the electrical properties of porcelain [9]. It is showed that resistant of sample increases at 5 degree temperature when adding the Zealot which is added at higher temperature.

However the resistivity depended on the sintering temperature at the same time of addition.

Experimental

The porcelain was prepared by using ceramic technique involving solid state reaction using the composition consisting of raw materials within following fraction 50% kaolin, 25% feldspar, 25% silica in the form of grinding powders. The X-Ray diffractometre is an instrument for studding sample , for phase identification and study of preferred orientation a full scan of 2θ from (5–80 degrees) which were analyzed to calculate (d) (interatomic spacing) at to index (hkl),the relative intensities were taken from (XRD) pattern using highest peak as reference . The sample of the formula porcelain and additives at different concentrations from ZrO2 (2, 5 , 10, 15,20 wt %) were prepared by the ceramic method.

The samples of composites(porcelain and ZrO2 additives) were mixed for (6 hr) , after that the mixture was pressed to pellets with diameter 1.5 cm and thickness 0.7 cm , these pellets were sintered at (1300℃) in air for (3 hr) , the sample was then slowly cooled at rate of (2℃ per min) , the bulk density and open porosity were measured by using Archimedes with water as the immersion medium , the dielectric constant was measured by using precision LCR meter model HP 4284 with the scale 50Hz to 1 MHz .

The surface of discs is polished air- dried silver epoxy electrical contact was deposited.

Results and Discussion

X-Ray diffraction analysis the porcelain pattern that is produced by solid state reactor method and sintered at (1300℃) is shown in figures (1,2,3,4). Data of X-Ray diffraction for

porcelain summarized in table (1),the lattice parameters were evaluated by using the values of d- spacing which are evaluated by using Brag law [10] and compared to the value of reported in joint committee on powder diffraction standard cards JCBPS [11].

Bulk density

The data in figure (5) refer that the bulk density was measured on the pellets sintered at (1300℃) in air form three hours , it can be shown that figure (5), the bulk density increase with the increase of ZrO_2 content and that may be due to the replacement of ZrO_2, particles in the main composition of porcelain. Next it is clear that the increase of the density of the composite is due to the sintering temperature having the highest value at (1300℃)

Porosity

The open porosity can be calculated from P = (M – D)/ (M – S)*100 , when (D) is the Dray weight in (gm), (S) is the weight of sample after immersing in distilled water , M is the weight in the air of sample saturated with water (gm) and suspended in air through a balance (gm). Figure (6) shows that, the effect of ZrO_2 content on the porosity of porcelain , the porosity decreases sharply due to the increase of ZrO_2.
Additive may be the filling of most of the open pores with ZrO_2 particles and making good dense body as seen with the results of density.

Dielectric properties

The variation of dielectric constant as a function of ZrO_2 additives (Wt %) for porcelain, is shown in figure (7), It can be shown the values of dielectric constant increases with the increase of ZrO_2 additive (Wt%) , it may be due to the presence of some micro crakes in the ceramic insulators the cracks can be observed mainly near the quartz particles and those regions as shown where the crystalline place and multi-phase were absent [12].
The variation of the dielectric loss tangent as a function of ZrO_2as shown in figure (8), that additive (Wt%) for porcelain , it was found that the dielectric loss tangent decreases due to increase in content as in figure (4)content.

Conclusion

In summary of the attempt for elaboration of porcelain samples with simple techniques it can be found the experimental results show that local raw materials are very quiet suitable for porcelain could be produce the results obtained by using the locally available raw materials porcelain with good dielectric and physical properties.

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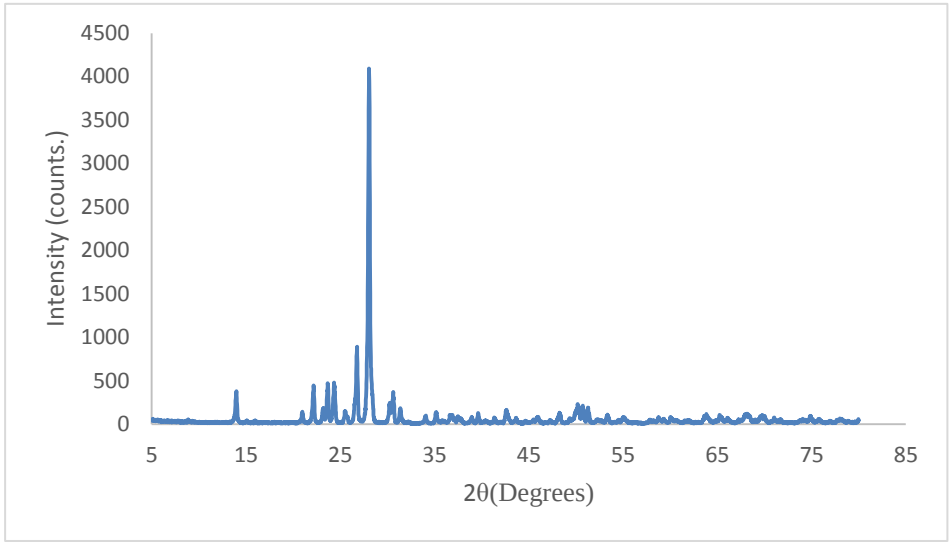
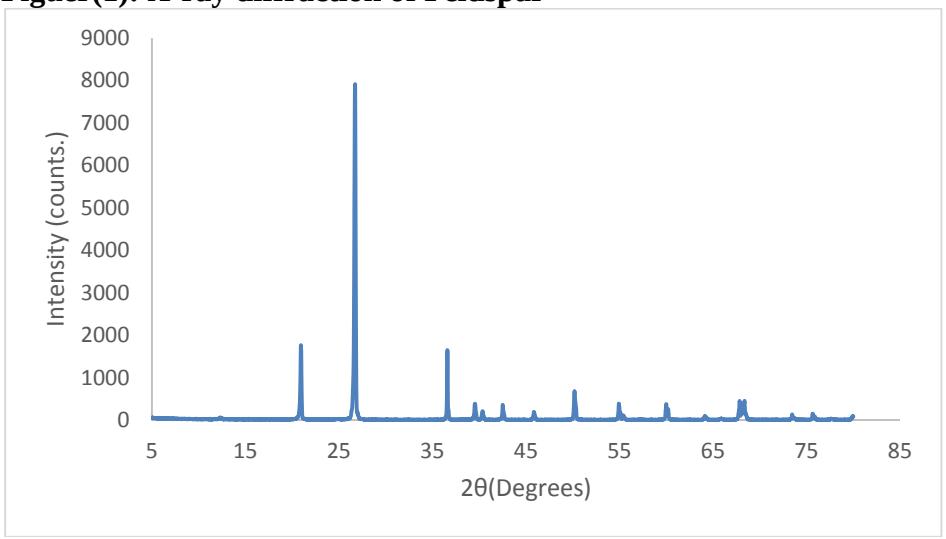
Table (1): X-ray diffraction data of porcelain

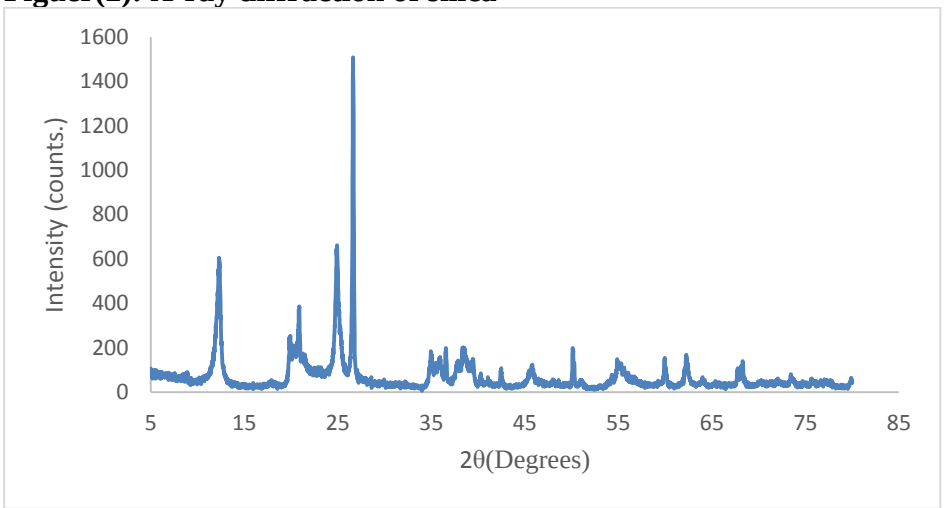
$2\theta(degrees)$	d (A°)	hkl
21.15	4.19	100
26.58	3.34	101
26.96	3.3	006
33.45	2.6	116
35.39	2.52	300
39.71	2.26	161
40.57	2.22	111
41.07	2.19	200
42.70	2.11	223
50.36	1.81	003
55.12	1.60	103
60.14	1.53	211
60.85	113	113



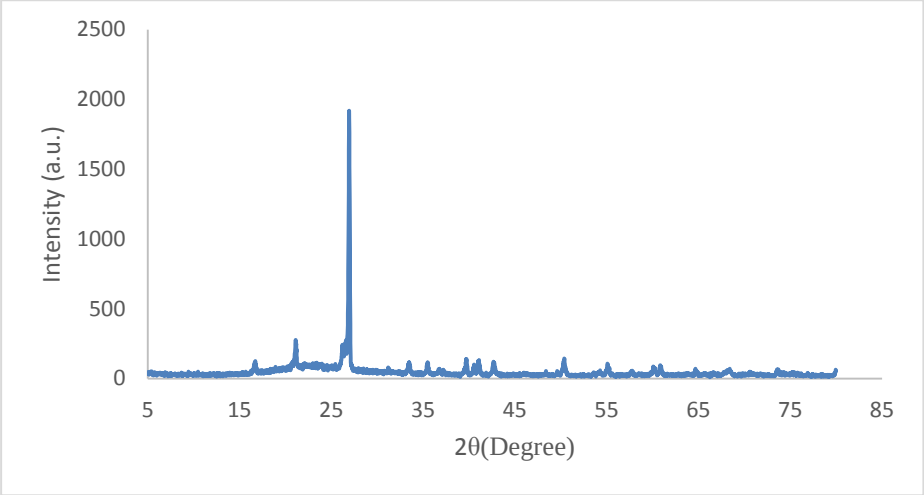
Figuer(1): X-ray diffraction of Feldspar



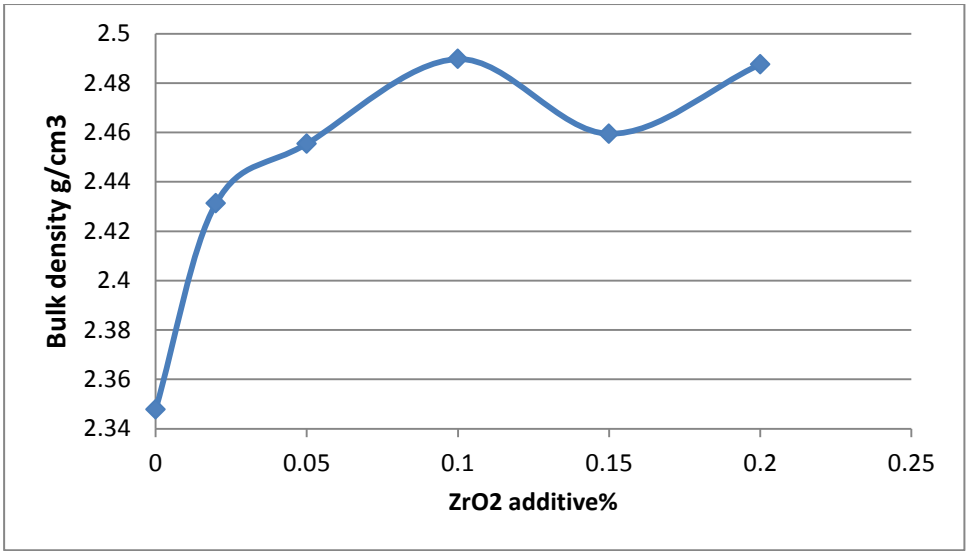
Figuer(2): X-ray diffraction of silica



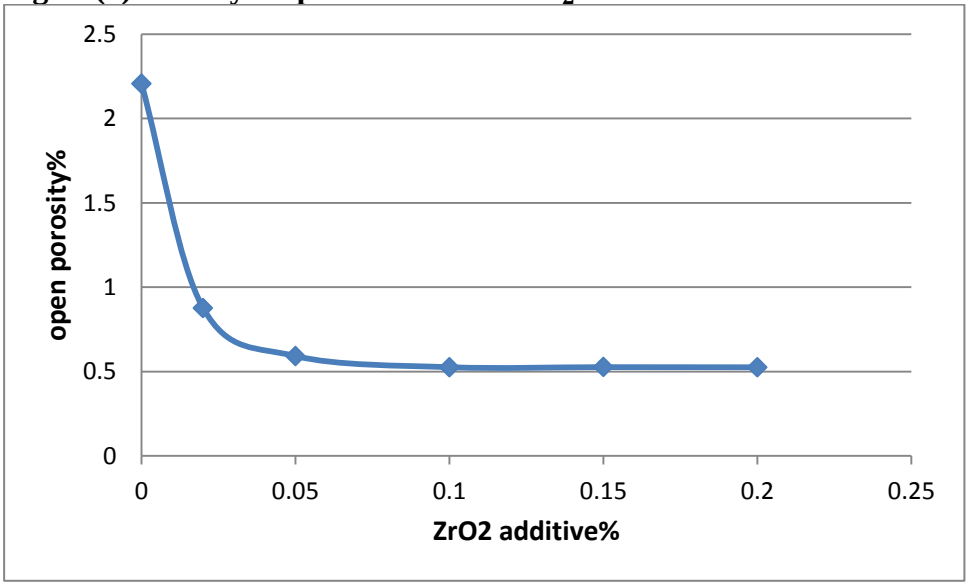
Figeru(3): X-ray diffraction of kaolin



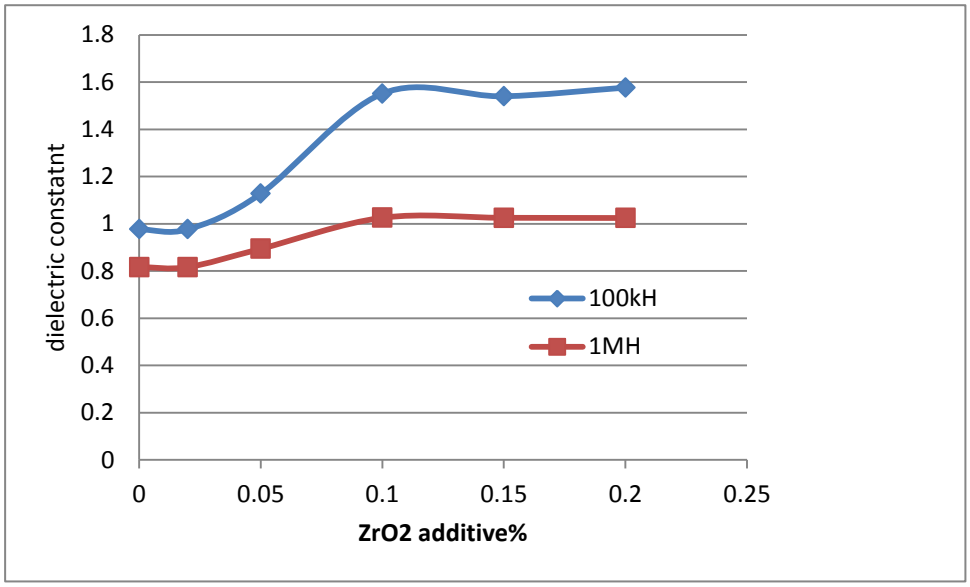
Figuer(4): X-ray diffraction of composition (kaolin , feldspar, silica)



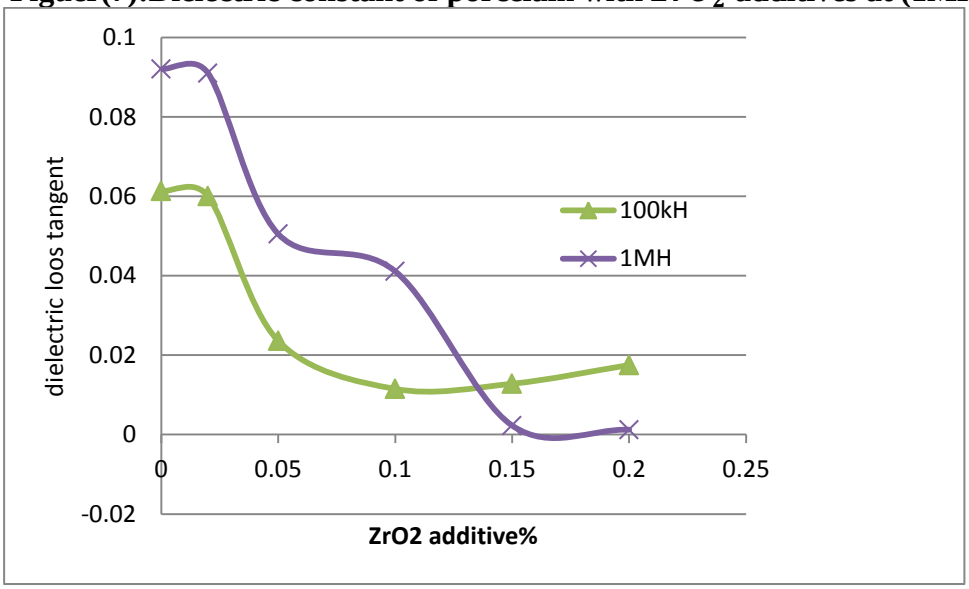
Figuer(5):Density of porcelain with ZrO_2 additives



Figuer(6):porosity of porcelain with ZrO_2 additives



Figuer(7):Dielectric constant of porcelain with ZrO_2 additives at (1MHz) and (100KHz)



Figuer(8):Dielectric loss tanget of porcelain with ZrO_2 additives at (1MHz) and (100KHz)

دراسة تاثير الزركونيا في بعض الخصائص الفيزيائية للبورسلين

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الخلاصة

تم في هذه الدراسة تحضير البورسلين بأستعمال التركيبة المكونة من مواد اولية (50% كاوؤلين ، 25% فلسبار ، 25% سليكا).
وبعد ذلك تم دراسة تأثيرنسب مختلفة من اضافات الزركونيا (20,15,10,5,2) $Wt\%$ في بعض الخصائص الفيزيائية للبورسلين المحضر والنماذج حضرت بطريقة التصنيع التقليدية و لوحظ من خلال تغير ثابت العزل والكثافة مع تراكيز الزركونيا المضافة بأنها تزداد مع زيادة تراكيز الزركونيا.
اما ظل زاوية الفقدان والمسامية فقد وجد بأنها تتناقص مع زيادة تراكيز الزركونيا المضافة .

الكلمات المفتاحية: بورسلين ، فلدسبار، اوكسيد الزركونيوم، ثابت العزل ،ظل زاوية الفقدان