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Study the Changes of Bending Specification Strength at Adding Glass Powder to Iraqi Kaolin

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Abstract

Recently the needs to certain types of ceramic products with specific properties in the industry and general public uses or especially for high-performance computing systems, the scientist go to the nature to obtain many types of these materials ecologically save, less processing mining, low cost, cheap, low efforts, and in sometimes with high industrial specifications. Because of the growing interest on environmental issues, this work carried out using the clay present naturally in Iraq to promote a sustainable processing of such materials, as bending resistant and mechanical properties. The results of this work refer that the highest value for bending resistant was 16.5 MPa. when the ratio was 20% glass powder / 80% kaolin; while the lowest value was 9.1 MPa. when the ratio was 0% glass powder / 100% kaolin; 11.5 MPa when the ratio was 10% glass powder / 90% kaolin; 16.5 MPa when the ratio was 20% glass powder / 80 % kaolin and finally 11.52 MPa when the ratio was 30% glass powder / 70% kaolin. This work shows that the best bending strengths obtained were 16.5 MPa when blending 20% glass powder / 80% Kaolin to manufacturing glass-ceramics; melting the mixed powder ≤1150^{o}C, this results give us the best limitations in such types of ceramic industry which decrease the production cost, time, efforts in the same time obtained a good best products quality in scientific and general public uses.

Key words: Glass powder; kaolin; bending; mechanical properties.

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1. Introduction

The products of clay and fire-prickles produced from it are ceramics materials, which needs special degrees of heat in ovens to complete ceramic stages (phases) of full burning to overcome these problems. Recently the needs to certain types of ceramic products with specific properties in the industry and general public uses or especially for high-performance computing systems to meet the demand arise with the increasing clock rate and transistor count of today's microprocessors, power dissipation which becoming a critical component of system design complexity[1]. Then and because that the scientist go to the nature to obtain many types of these materials with less processing mining, low cost, cheap, low efforts, ecologically save and in sometimes with high industrial specifications, as preparing glass ceramics by using the caolin with additives such as CaCO3. The mixture of metal and non-metal components most of them are Oxides, Nitrites and Carbides which have crystal complex structure with ionic or covalent bonds [2]. Today's industrial activities and human consuming habits are generating an ever-growing amount of all kinds of wastes. In response, considerable efforts are being conducted to find practical and economical uses for any existing waste [3]. Iraqi industrial activity contributes for the improvement of the quality of citizens life. On the other hand, it has a negative impact on the environment. These opposite aspects present a challenge to modern societies over the word, which must manage this delicate balance of the positive and negative aspects of the industrialization process. More than 100 active clay ceramic industries could supply a solution for the destination of such wastes by adding them to final products, mainly bricks. The addition of 5–10 wt.% of such oily waste produces an increase in mechanical strength, while the clear density, linear shrinkage and water absorption remained practically unchanged [4]. Because of the growing interest on environmental issues, studies are being carried out in Iraq to promote a sustainable processing of such materials, normally through recycling or reutilization of the generated residues. Recycling or reutilization of secondary products has many advantages as saving of energy in case of residues with a potential use as fuels, or residues which exhibit exothermic reactions during processing; elimination of the costs for treatment and removal of these residues; inertness of toxic residues without the emission of vapors as occurs in incinerators[5]. Reutilization of residues finds a wide application in the glass and in the ceramic industry [6;7]. The ceramic industry, especially red clay production, can incorporate heterogeneous residues from different origins and compositions without a significant depreciation of its quality. The residues generated from processing of ornamental rocks are rich in silicon and aluminum oxides, carbonates, metal oxides and other impurities; components like the ones present in the Iraqi traditional ceramic raw materials. For that reason, masses used for red clay production tolerate incorporation of various types of residues, even in significant amounts [7;8]. The researchers [9;10;11] analyzed the influence of the maximal burning temperature on such properties of the final ceramic product as density, overall shrinkage, water absorption and strength. The researchers were found that, after the burning temperature increased from 750 °C to 950 °C, density values of the ceramic body increase up to 11%, overall shrinkage – up to 56% and strength – up to 75 %. At the same time water absorption values decrease up to 8% [7]. Clay presents naturally in Iraq state and genesis as solid state rocks because of its impression in which takes its sintering, in elasticity features and inability permeations of water through it. Kaolin clays is watery aluminum silicate $Al_2O_3,2SiO_2.2H_2O$ or $Al_2Si_2O_5(OH)$, its crystal structure compose of two layers one is silicatetrahedral which associated with octahedral layer, kaolin contains 14% crystal water, 39.5% aluminum oxide(Al_2O_3) Alumina, 46.5 % silicon oxide (SiO_2) silica. These components represents the pure form of kaolin, but rarely found naturally in this form because it contains some impurities as silicides [13;14]. While the chemical analysis of Iraqi kaolin obtains from middle west site (using the Volumetric method mentioned by "general Iraqi company of geological and mining scanning") the components and percentage of each (Table 1):

Table 1: The components and percentage of Iraqi kaolin and impurities.

Total	L0.I	K_2O	Na_2O	MgO	CaO	TiO_2	Fe_2O_3	Al_2O_3	SiO_2	Oxygen
100	12.94	0.34	0.3	0.34	0.96	1.2	0.83	34.41	46.66	%

Kaolin as raw material used in the ceramic industry, because of its ability to compose cohesive, sticky substance when mixed with water to formation and modeling after dryness in air to obtain a solid state when heating till redness, the molecular formula is : $H_2Al_2Si_2O_8H_2O$ or $Al_2Si_2O_5(OH)_4$ or $Al_2H4O_9Si_2$; Molecular Weight: 258.156 g/mol [14]. If we crush the glass to be powder it appears in air more shiny because it transfer to white nontransparent powder because the powdering will duplicate the glass piece faces which reflex and deflect the light particles, but putting the powder inside water it disappear immediately because both the glass powder and water have nearly the same coefficient deviation and reflecting number; heating glass materials above 900ºC crystallization occurred[15].

2. Sintering of Ceramic Materials Clay Firing

The substructure microscopically constitution of material particles play a great important role in studying its properties, elements have unique atoms and thus, unique properties, in ceramic sintering by heating ceramic powder up to high temperature for specific time causing bonding its particles together leading to increase strength and density[16]. The aim of this work is to improves and to meet the demand arise to certain types of ceramic products with specific properties in the industry, general public uses especially for high-performance computing systems, transistor, microprocessors and other fields by using the Iraqi kaolin in ceramic production .

3. Materials and Methods

After preparing and formation the samples some procedures are done to take them the final shape, the kaolin blended in electrical blender for four hours at the fallowing percentages (Table 2):

Table 2: Percentages of kaolin blending.

Kaolin + Glass	Kaolin 100%	Glass 0%
	Kaolin 90%	Glass10%
	Kaolin 80%	Glass20%
	Kaolin 70%	Glass30%

Samples were pressed using eight tons load, one direction manual hydraulic pressing machine with adding 2%

of alcoholic polyphenol. Then removed the water and wetness by dryness at 120 °C for twenty-four hours and firing at 1150°C for one h. To measuring the bending resistance select randomly six samples according to the ASTM Standered-C674,Aplying the bending strength formula in mega pascal (MPa) = $(3P_f \times L) / 2W \times t^2$ (were P_f : loading till fracturing(N); L: distance between predicate (mm); W: crosswise of sample (mm); t: thickness (mm), each result or value is represents the average reading for three samples (Figure. 1).

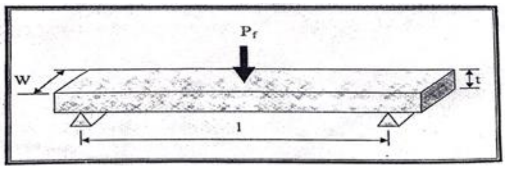

Figure 1: Measuring the bending resistance

4. Results

The results shows that the bending resistant was 9.1MPa when the ratio of glass powder / kaolin was 0% /100% respectively; 11.5 MPa when the ratio was 10% glass powder / 90% kaolin; 16.5 MPa when the ratio was 20% glass powder / 80 % kaolin; 11.52 MPa when the ratio was 30% glass powder / 70% kaolin (Table 3).

Table 3: The bending resistant values at different percentages blending of glass powder with kaolin.

Bending resistant value (MPa.)	Glass powder	Kaolin
9.1	0%	100%
11.5	10%	90%
16.5	20%	80%
11.52	30%	70%

The table 3 refers that the highest value for bending resistant was 16.5 MPa. when the ratio was 20% glass powder / 80% kaolin; while the lowest value was 9.1 MPa. when the ratio was 0% glass powder / 100% kaolin (table 3;Figure 2 and 3)

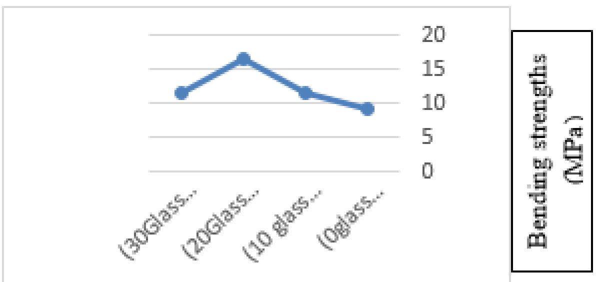

Figure 2: Bending strengths (MPa)

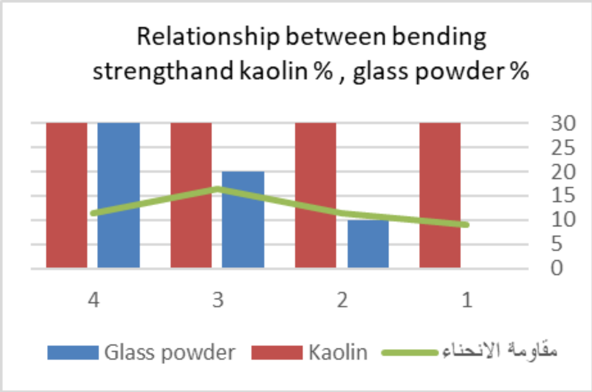

Figure 3: Relationship between Bending strengths (MPa) and kaolin%, glass powder %

5. Conclusion

This work improve that the best bending strengths obtained were 16.5 MPa when blending 20% glass powder / 80% Kaolin to manufacturing glass-ceramics; melting the mixed powder ≤ 1150ºC; this differences in bending strength is due to the lower granular volume for kaolin powder which is increase the cohesion power between granules to become glass powder at limited levels to increase the bending strengths that is to filling spaces of kaolin samples after conversion to semi-soluble phase streamline easily through these spaces; however the burning at 1150ºC will transferring the oxides (KaO, MgO, NaOH) to glasses phases which in turn lead to increasing the bending strengths. From the results of this work we noticing that bending strengths changed to the better within certain glass powder percentages (at 30%) glass in which the highest percentage, occurs decrease in bending strengths that is because the increasing of glass percentage, in addition to presence of high percentage of silica in kaolin composition which in turn leads to turnover when increasing temperature to material semi glasses which is more crispness leading to decrease mechanical properties. This results give us the best limitations in such types of ceramic industry which decrease the production cost, time, efforts in the same time obtained a good best products quality in scientific and general public uses.

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