THE EFFECT OF BENTONITE ON THERMO-PHYSICAL PROPERTIES OF WASTE BASED COMPOSITE

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ABSTRACT: The effect of bentonite on thermo-physical properties of waste based composite were investigated. The cystallization behavior of this composite in the presence of Bentonite as filler was studied. This composites were prepared using combination of soda-lime glass (SLG) and borosilicate glass (BSG) powders with spent bleaching earth (SBE). The weight percent ratio for SLG and BSG have been fixed to 65% for the combinations of both glasses with particle size of approximately 45µm. These glass composites were formed using uniaxial dry pressing and sintered at 750°C and 850°C with the heating rate of 2°C/minute.The glass composite were analyzed in terms of its physical properties and crystalline phases presents in the sintered composite were identified by X-Ray diffraction (XRD) and relate with microstructure using scanning electron microscopy (SEM). It was observed from XRD studies that quartz initially precipitated and loading SBE increased to 25%wt, phases coesite, cristobolite and carnegeite were precipitated. The effect of bentonite on the density and hardness of these composite were characterized by Vicker's and the results revealed a significant increase in density and hardness of the fully crystallised system. SEM observation revealed that exceeding 10% of bentonite led to major presence of pores.

KEYWORDS: *bentonite, recycle glass composite, sintering, spent bleach earth*

1.0 INTRODUCTION

Nowadays, the amount of trash is increasing rapidly. There are many negative effects of not recycling like climate change, many landfills needed and the cost to convalescent is high and many more. If waste is not being recycled, the world would be extremely hazardous. One of the best solutions is by recycling and turning it into a beneficial and environmentally friendly product. [1]. There are several types of glasses, mainly are Borosilicate glass (BSG) and Soda-Lime glass (SLG). The waste term also implied to natural resources. In Malaysia, there are a several types of natural sources. All the natural waste is safe to be used and not hazardous because it does not contain any chemical composition. The waste from palm oil processing can also be recycled into a new product. A recent study by [2] reported that spent bleach earth (SBE) powder has improved the hardness. By reusing the waste like BSG, SLG and SBE, a lot of problems could be solved. It has been reported by [3] that additional filler such as bentonite has shown an improvement in the color appearance. Therefore, bentonite has been used as a binder in this project. The aim of this project is to turn the waste into a beneficial product. The purposes of using waste are to be environmentally friendly and to save the cost of manufacturing a new product.

2.0 MATERIALS AND METHODOLOGY

SLS recycled glasses were crushed by using ball mill grinding machine. The powder is sieved using a vibratory sieve shaker with the size of 45µm as described in previous study [4]. The supplied SBE was unprocessed so it has been processed using sonication method. The raw SBE was mixed with ethanol in a beaker before sonicated in the ultrasonic machine for 20 minutes before dried at ambient temperature. The mixing process is where the batches are being mixed by using ball mill machine. The powder compacted by using uniaxial die pressing machine which 1.5g (for circle mold) and 3.5g (for square mold) at 40MPa (3.5 tonnes) . The compositions of this composite are shown in Table 1. The obtained green bodies were subjected to sintering treatments. All samples were sintered at 750ºC and 850ºC with 2 ºC /min heating rate and 15 minutes holding time. The sintered samples were analyzed based on X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), density and Vickers hardness.

Table 1:Ratio of filler content in green glass ceramic

Materials / Sample Code	SLSG (wt.%)	BSG (wt.%)	SBE (wt.%)	Bentonite (wt.%)
B 1	32.5	32.5	30	5
B 2	32.5	32.5	25	10
B 3	32.5	32.5	20	15
B 4	32.5	32.5	15	20
C 1	32.5	32.5	35	-
C 2	32.5	32.5	33	2

3.0 RESULTS AND DISCUSSION

Figure 3.1 shows the XRD results for sample B1, B2, B3, B4, C1 and C2. Most of the samples have two to five peaks for each sample and the compound are on the same peak. The compounds in samples are Cristobalite, Coesite, Anorhite and Carnegeite. The cristobalite came from the SLG and BSG glasses. It can be seen from Figure 3.1, sample B3 has the highest intensity at peak around 21.6 2 Theta (°) which is referred to SiO_2 phase. The main crystal phase at that peak is Cristobalite (SiO_2). However, from the result, not all samples consisted cristobalite compound. This is due to loss of ignition (LOI). The other compound or elements in these samples are Carnegeite ($NaAlSiO_4$), Silicon Oxide (SiO_2) and Coesite (SiO_2).

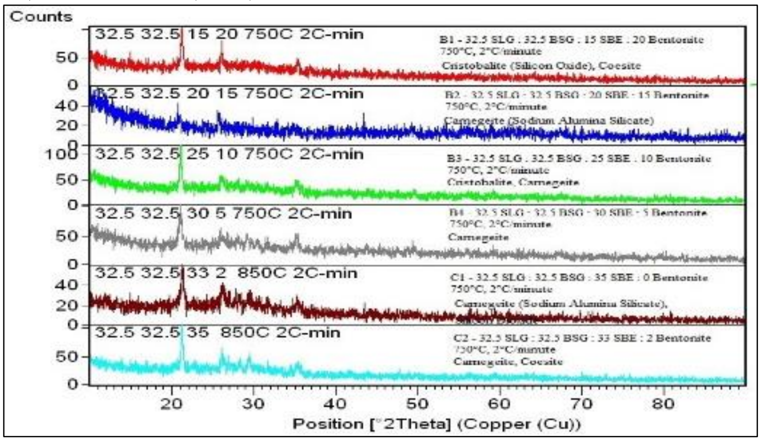


Figure 3.1: Diffraction on sample B1, B2, B3, B4, C1 and C2.

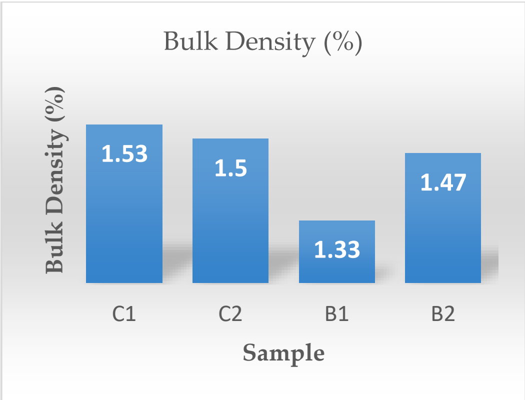


Figure 3.2: The bulk density percentages for sample C1, C2, B1 and B2

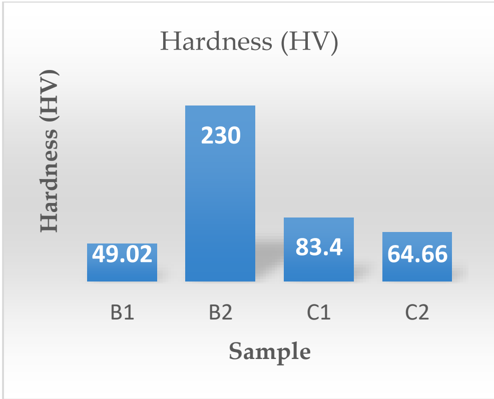
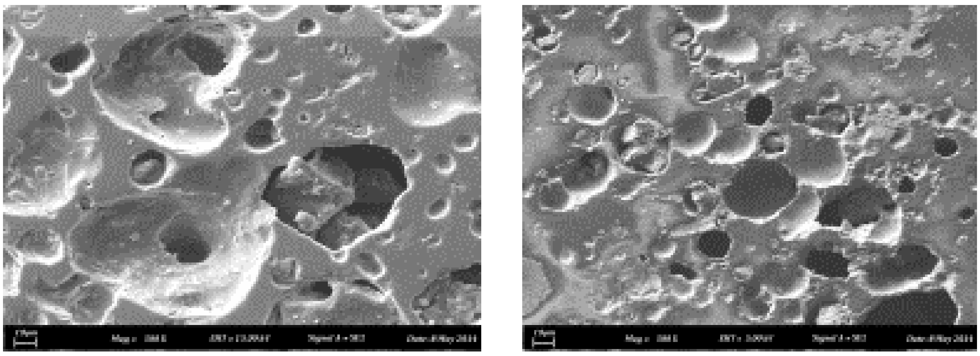


Figure 3.3: The bulk density percentages for sample C1, C2, B1 and B2

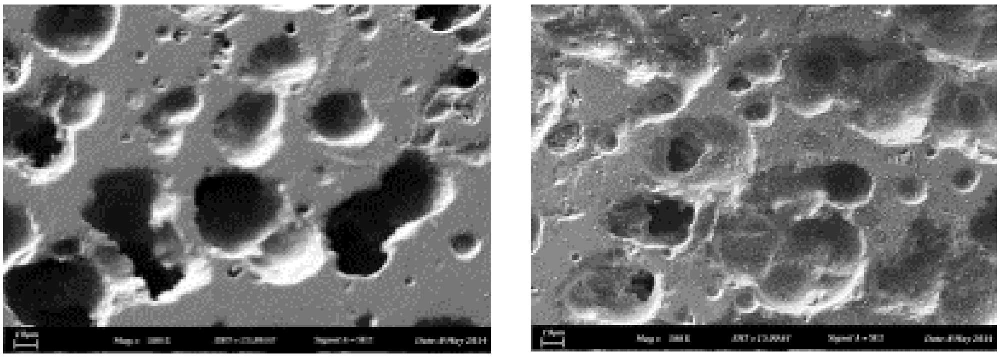
Figure 3.2 shows the highest density was C1. It could be seen that with less percentage of Bentonite, the samples present high percentage of density. One of the reasons might be because of the addition of the BSG and Bentonite. SBE was expected to be denser than other materials in the compounding, which tend to be evaporated.These are the reasons why the samples with high SBE percentage show high density where Bentonite has a density of 0.593mg/mm^3. Besides that, the density of the materials relies on the densities of its single constituent. However, in the status of glass-ceramic, other factors also marginally influence on the density of the final product [5]. For hardness test, only four samples have been chosen due to the dimensional stability and surface roughness. All the samples with the rough and protruded surfaces were eliminated from the microhardness testing. The chosen samples for this testing are sample B1, B2, C1 and C2. The results of the testing are shown in Figure 3.3. It was crystal clear that sample B2 with the composition 10% of Bentonite has the highest mean of hardness. Even the samples were cracked in the middle, but it still got the highest hardness reading. One of the factor of low hardness value is because of the low pressure during the forming process. For samples C1 and C2, the pressure used to be 17 MPa (1.5 tonnes), compared to samples B1 and B2 which was 40 MPa (3.5 tonnes). High pressure during the forming process, promotes bonding between the green pallet which expected to give higher hardness as proven in Figure 3.3. However, without the addition of SLG in the composition, the samples turned too soft [3]. From this work, it can be summarized that BSG is causing the samples to be softened.



(a) B1 (b) B2

Figure 3.4: SEM analysis of sample B1 and B2 with 500x magnification.

Figure 3.4 and 3.5 show micrograph SEM at dofferent loading of Bentonite. It can be seen that the pores for each of the selected samples reveal the pores at different sizes. These results are possible explained based on the development diffraction XRD where noises pattern depicted. These noises proved is based on the phases precipitated which is glassy phase. It is expected the combination of the BSG and SBE contributed the development of porosity. Based on [2], with the addition of SLG weight percent ratio, the sample gave better surface finishing with less porosity.



(a)C1 (b) C2

Figure 3.4: SEM analysis of sample C1 and C2 with 500x magnification

The crystallization and rigidity are higher when the surface of the samples is smooth due to Al and Na element. These two elements causing the glass composites to be crystallized. However, with more weight percent ratio of Bentonite, the porosity was reduced. This is because the Bentonite were acting as a filler. The filler will occupy the pores and give better bonding to the samples. With less pores, the samples directly will absorb less water. On the other hand, the addition of high volumes of recycled waste glass results in less pore porosity [6].

4.0 CONCLUSION

It was observed from XRD studies that quartz initially precipitated and when the loading SBE increased to 25 wt.%, phases coesite, cristobolite and carnegeite were precipitated. The effect of bentonite on the density and hardness of these composite were characterized by Vicker's and the results revealed a significant increase in density and hardness of the fully crystallised system. SEM observation revealed that with more weight percent ratio of Bentonite, the porosity was reduced.

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