Influence of size particles of SLS glass on properties of sintered SBE reinforced glass waste composite

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ABSTRACT – The properties of sintered glass waste composite was investigated with two varying size particles of glass waste (SLS) at different loading of spent bleach earth (SBE). The composites were exposed to single step heat treatments in order to produce glass-ceramics condition. This study is focused on physical testing to measure the physical properties combined with microstructural analysis of thev cross section surface using scanning electron microscopy (SEM). ASTM C373-88 analysis was used to assess the variability in density, porosity and water absorption. The results showed that finer size particles in all composition contributed better in physical properties. These properties slightly decreased linearly with increasing SBE loading for both particles sizes and was significantly reduced in 40% of SBE. Microstructure analysis indicated that the present of pores within the glass waste composite was dominated by agglomeration.

1. INTRODUCTION

The fabrication of glass waste can be develop into technical glass ceramic by undergo heat treatment that consist outstanding properties [1]. Moreover, this material also can be transform into a ceramic composite material which glass act as matrix that cause increase in Young's modulus, hardness and fracture toughness depending volume fraction of glasses [1]. The waste glass can be identified in few type of materials such as borosilicate glass, soda lime glass, potash lime glass and others. It has been reported that glass act as matrix in natural fiber composite consists of high durability and non-environmental effect [2,3]. Hence, that cause glasses more favorable and have better properties to be recycle and change into acceptable application. Research based on natural waste had been embarked to transform a useful product as example filler for the composite [4]. Spent bleaching earth, SBE is waste material that origin from edible oil industry and classified as organic waste. Referring to Quesada and Iglesians [5] stated that the SBE has been used clay brick act as pore forming agents indicates that bulk density and mechanical strength is increase but total porosity and water absorption decrease compared to the pure clay brick. Hence, by adding SBE as filler in glass waste matrix, it is expected that the properties of glass waste composite will be improved. Reported by Zhang et al [6], the composite strength increases with decreasing particle size. Smaller particles have a higher total surface area for a given particle loading. This demonstrates that the strength increases with increasing surface area of the filled particles through a more efficient stress transfer mechanism. Therefore, by changing size of particle it is believe that the strength and different properties of glass waste composite will be affected.

2. METHODOLOGY

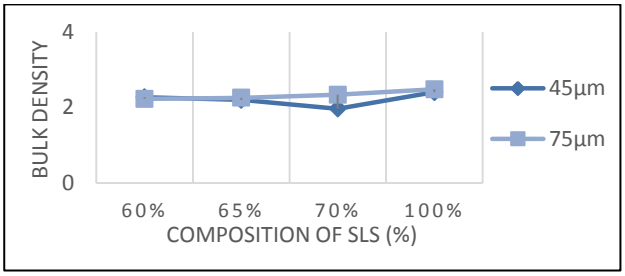
Glass waste from soda lime glass was collected from the household waste. The preparation of the glass waste undergoes crushing, ball milling, and sieving at 45μm and 75μm. The raw SBE has undergone a cleaning process to extract oil using sonification process followed by filtration and drying process until the SBE was in powdery form. The particle size distribution for SBE was determined using particle size analyzer, Mastersizer 2000 Malvern Instrument Ltd model. The compositions is shown in Table 1. All the samples were produced using conventional powder processing methods involving ball milling and uniaxial pressing before sintering. The obtained green bodies were subjected to sintering treatments using laboratory electric furnace Carbolite 1300 model at 750˚C at constant heating rate of 2˚C/min and 15 minutes dwelling time. The crystalline phase analysis were conducted using X-ray diffraction (RIGAKU Model MINIFLEX II) operating at 30 kV and 15 mA with Cu Kα radiation. The detector was scanned in the range of 2θ angle from 10° to 80°. Data was collected at room temperature using Cu Kα radiation (α=1.54178 Å). The percentage of bulk density, porosity, water absorption of the sintered glass ceramic was measured following ASTM C373 standards using pellet specimens. The microstructure of the glass waste composites was inspected using SEM EVO 50 (Carl Zeiss SMT, UK) at accelerated 15 kV. Surfaces of the specimens were coated with a conductive gold layer using SC-7620 Mini Sputter Coater (Quorum, UK).

Table 1 The ratio of glass waste composite preparation.

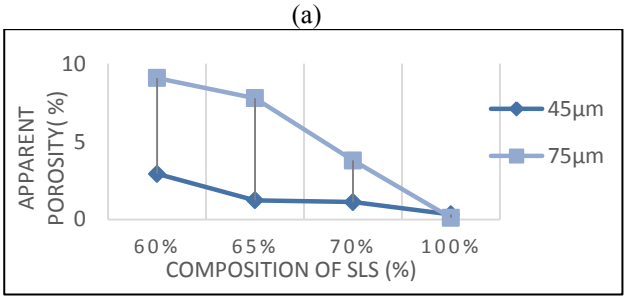
Sample 75µm (wt%)	A1	A2	A3	A4
SLS	60	65	70	100
SBE	40	36	30	-
Sample 45µm (wt%)	**B1**	**B2**	**B3**	**B4**
SLS	60	65	70	100
SBE	40	35	30	-

3. RESULTS AND DISCUSSION

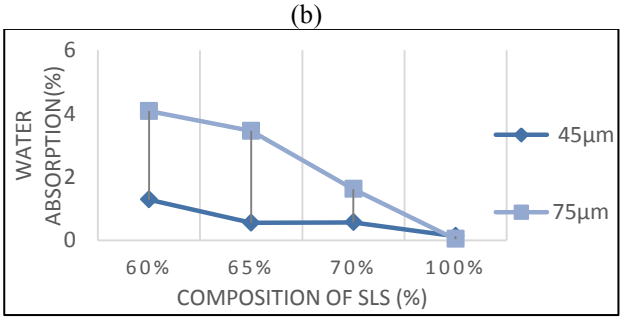
Figure 1(a, b, c,) shows that the axial shrinkage, bulk density, apparent porosity and water absorption of glass waste composite in relations to the increasing of the SBE content.



(a)



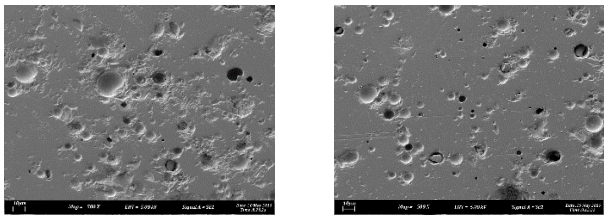
(b)



(c)

Figure 1 Physical properties of glass waste composite for a) bulk density, b) apparent porosity and c) water absorption.

It can be seen clearly that, in general, as the SBE content increased, porosity and water absorption increased. A significant increase of % porosity was observed in 40 % loading of the SBE content with 75µm of size particle. This finding is coherent with the microscopy observation in Figure 2. Similar trends were also observed in bulk density with finer size. The formation of pores in glass ceramic could be influenced by many factors such as volume of the glass powder, filler [3,4] and others. Works by Juoi [4] on the slug powder (BS) filled glass- ceramic indicated that the porosity increased with increased of the BS content due to lack of glassy form to aid viscous flow. Moreover, it is also expected that high sintering temperature causes filler such as SBE is burned into gas thus pores present in the process [5].



(a) (b)

Figure 2 Pores present in glass waste composite for a) 45µm and b) 75µm.

4. CONCLUSION

Glass waste composites incorporating SLS waste glass filled with SBE powder has been produced by sintering at 750^{0}C at a rate of 2^{0}C/min and 15 minutes of soaking time. With increasing amount of SBE content, the porosity and water absorption are increased, resulting in reduction of the bulk density values for both size particles. When the particles size increased,–morphology of pores changed and appeared to be more open and less dense which reveal the composite dominated by agglomeration of SBE.

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