Available online at http://www.journalijdr.com

International Journal of
DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 3, Issue, 12, pp.065-067, December, 2013

Full Length Research Article

ADHERENCE OF THE BIOSILICA TO THE BIOCERAMIC TILES

Amutha, K. and *Sivakumar, G.

Department of Physics, Annamalai University, Chidambaram, Tamilnadu, India

ARTICLE INFO

Article History:
Received 28th September, 2013
Received in revised form
11th October, 2013
Accepted 06th November, 2013
Published online 18th December, 2013

Key words:
Synthesized biosilica,
Ceramic tile properties,
UPV.

ABSTRACT

Vitrified bioceramic tiles were subjected by the incorporation of synthesized biosilica from bioresidue of Rice straw ash. The partially and fully substitution of biosilica for quartz in porcelain formulation enhances the physico-mechanical parameters. The ultrasonic pulse velocity was correlated with the compressive strength. The result which confirms that the biosilica act as a filler in porcelain tiles thus improves the mechanical behaviour of bioceramic tiles than reference tile. This synthesized biosilica has a highly substantial for quartz and it is environmental pollutant control in a sustainable way. Thus, biosilica is a suitable material for the production of vitrified bioceramic tiles.

Copyright © 2013 Amutha, K. and Sivakumar, G. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Generally, triaxial porcelain is referred as clay-feldspar-quartz and quartz, a source of silica, which commonly used filler for the microstructure development and strength enhancement. Clay has the plasticity property, feldspar and quartz has the non-plasticity material in porcelain composition which contributes the densification (Kausik Dana *et al.,* 2004; William M. Carty and Udayan Senapati, 1998). The recycling of bioresidue is incorporation of value added by product of biosilica and it applicable to ceramic product. The reinstate of quartz by biosilica is to develop the attention in ceramic tiles manufacture. In few decades, nanosilica plays a prominent role in research field. The synthesized biosilica acts as a filling agent, catalyst, electronic device, drugs delivery, adsorbent, pharmacy and so on (Hessien *et al.,* 2009). Using sol-gel method the biosilica was synthesized from the bioresidues such as rice straw, maize stalk and cow dung. The synthesized biosilica powders are rich in SiO_2 and the purity is higher than the quartz. The size of the biosilica particles is in nano level and it is less than the quartz particles (Amutha and Sivakumar, 2013). The high purity amorphous SiO_2 can react as filler material to reduce the use of quartz and mullite formation was rapid at lower temperature. Many literature reviews of raw materials used in porcelain manufacture showed that the use of synthesized biosilica has not yet been investigated. Our aim is to investigate the fully substitution of biosilica for quartz in ceramic formulations, for the augmentation of strength behaviour. The physico-mehanical properties and Ultrasonic Pulse Velocity (UPV) are to be carried out and to correlate with them.

***Corresponding author: Sivakumar, G.**
Department of Physics, Annamalai University, Chidambaram, Tamilnadu, India

EXPERIMENTAL PROCEDURE

MATERIALS

Porcelain formulation of raw materials such as china clay, ball clay, feldspar and quartz were obtained from M/S. Orient ceramic Industry, Viruthachalam, Tamilnadu. The standard formulation of porcelain tiles used as a reference consisted of clay (60%), feldspar (30%) and quartz (10%). In this study the quartz was changeover by biosilica (RS-BS) synthesized from Rice Straw Ash (RSA) using sol-gel method (Amutha and Sivakumar, 2013). The Oxide composition of the ceramic body (clay & feldspar) and quartz materials were analysed (Table 1).

Tiles preparation

The selected materials were weighed and mixed as per the composition given in Table 2. 'SC' represents the standard ceramic tile, 'RSC' stands for synthesized silica from RSA blended ceramic tiles.

Table 1. Oxide composition (wt%) of Ceramic Materials

Composition	Ceramic body (wt %)	Quartz (wt %)	Biosilica (wt %)
SiO_2	60.270	98.440	99%
Al_2O_3	30.930	0.723	-
CaO	0.214	0.126	-
Fe_2O_3	1.432	0.159	-
Na_2O	1.190	0.180	-
K_2O	4.245	0.294	-
MgO	0.140	0.045	-
TiO_2	1.215	0.020	-
ZnO	0.004	-	-

Table 2. Batch composition of Ceramic Tiles

Tiles	Clay (wt %)	Feldspar (wt %)	Quartz (wt %)	Biosilica (wt %)
SC	60	30	10	-
RSC1	60	30	7.5	2.5
RSC2	60	30	5	5
RSC3	60	30	2.5	7.5
RSC4	60	30	-	10

Each batch was milled, homogeneously grinded by ball mill for 12 h in dry process in further to use (Felix Singer and Sonja S. Singer, 1963). Addition of water upto 5-6% to the dry powder for making square tiles (25 mm X 25mm X 5 mm). The moisture content (4-5%) of ceramic tiles were dried for 48 h in normal atmosphere. The dried (green) tiles were sintered at 1250°C in a kiln under controlled temperature then the specimens were subjected to various studies for quality assessment. According to ASTM, the physical performance was described in terms of Linear Shrinkage (LS), Water Absorption (WA), Porosity (P) and Bulk Density (BD) (Felix Singer and Sonja S. Singer, 1963; Martin-Marquez *et al.,* 2008). The Compressive Strength (CS) of the fired specimens was recorded by using a universal testing machine available at Manufacturing Engineering, Annamalai university, Chidambaram. Time of flight of the longitudinal and the shear waves of the tiles was measured through an Olympus Panametrics-NDT model 5800, IIT Madras, Tamilnadu.

RESULT AND DISCUSSION

The summary of the physical properties results obtained from the bioceramic tiles are shown in Figure 1. From the results, the properties of the standard tile is differ from bioceramic specimens. The linear shrinkage percentage of the bioceramic

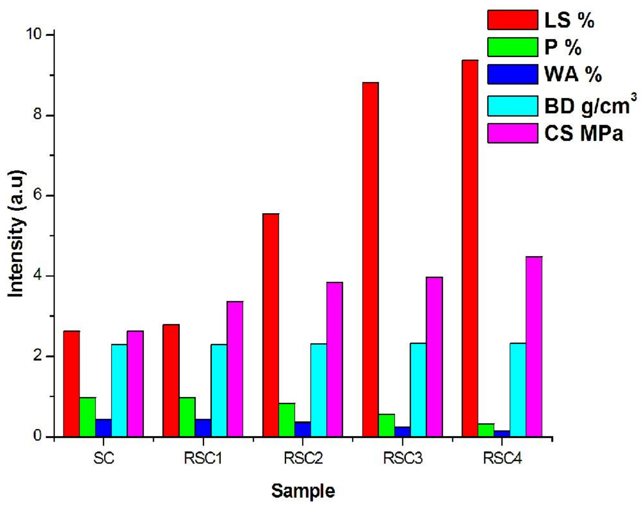

Fig. 1. Physico-mechanical properties of Bioceramic tiles

tiles are found to increase with increasing biosilica content. Smaller particles occupied less space and it gives the compactness under the sintering process. Hence the significance particle size contributes towards the shrinkage parameter. From the bar graph (Fig.1) it is clear that the physical properties depends on the size and moisture level ignition of the material. It was proved that in place of quartz by biosilica which attributes lower water absorption as similar to porosity and it indicates the vitrification. While the sintering process, it gives raise to the elimination of pores through viscous liquid bloating comes to cool when biosilica increases. Water absorption and porosity percentages are simultaneously decreases with an increase in bulk density due to the biosilica. This phenomenon was a result of lower value of loss on ignition of biosilica as against quartz. When linear shrinkage is higher it affects the pores due to the closure of voids thus leading to reduction in porosity (Benneth C. Chukwudi *et al.,* 2012). In the fact that densification depends on reduced pore spaces and hence which is density dependent. The compressive strength of the specimens is quite correlated with all parameters. The biosilica substituted tiles have better values than the reference tile. The tendency towards higher mechanical strength with higher density and shrinkage as well as lower porosity.

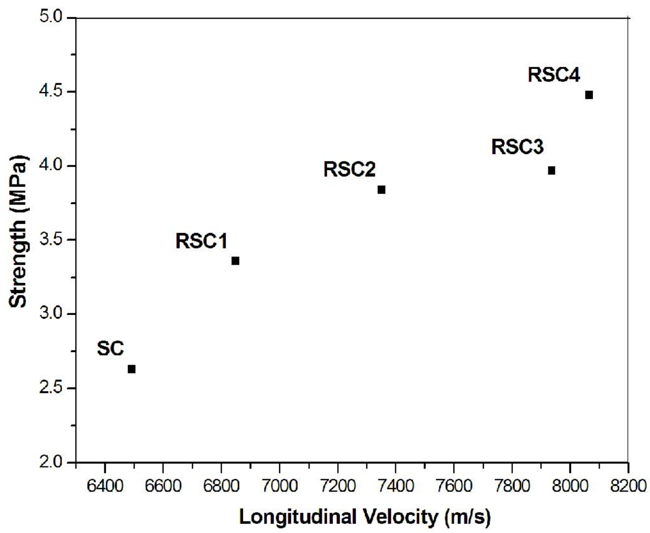

Fig. 2. Longitudinal velocity vs Strength

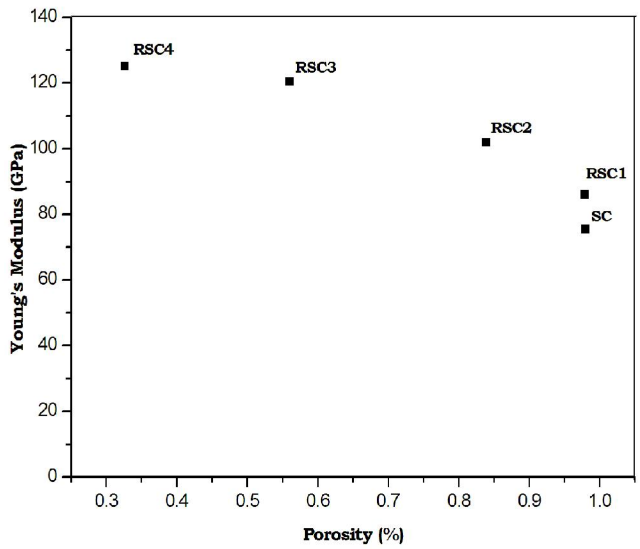

Fig. 3. Porosity vs Young's modulus

This finding was expected that the substitute of biosilica leads to the increase of vitrification level and to reduce internal cracks and the voids formation. The liquid phase sintering which eliminates the pores and the feldspar react with amorphous silica to interlock the particles for the development of strength behavior (Ritwik Sarkar *et al.,* 2007). The bioceramic tiles are higher strength than the standard tile and it is concluded that the nano sized biosilica exhibits greater mechanical strength when compared to quartz (Agenor De Noni Junior *et al.,* 2009). The mechanical strength of the ceramic tiles depends on its elastic properties, surface and internal defects and the character of the force to which it is subjected. The ultrasonic non destructive testing has been found to be one of the best technique to study the elastic properties of the ceramic tiles. Figure 2 and 3 shows the ultrasonic pulse velocity and young's modulus, respectively with the strength and porosity of the ceramic tiles. The result shows that when the longitudinal velocity increases with strength corresponding to biosilica increases. There is also a relationship between young's modulus and porosity of ceramic tiles, which helps to determine the strength behavior. The increase in ultrasonic velocity and compressive strength by corresponding to the biosilica increases. The strength and ultrasonic pulse velocity are strongly controlled by the presence of defects. The size of the filling agent decreases leads to an intensification in modulus of elasticity and to reduce in natural flaw size.

Conclusion

The fully changeover of quartz by biosilica in ceramic tiles promotes the water absorption and porosity becomes closer to zero value. Porosity of the specimens gradually decreases with an increase in compressive strength is progressively incorporated as a participation of biosilica. Percentage of the biosilica, is an essential part to amplify the modulus of elasticity and to decline the natural flaw size. The sizes of the biosilica are very less than the quartz and it acts as filler to interlock the neighbour particles to gain the maximum strength. Without modifying the process and technological conditions the new material of bioceramic tiles was manufactured. It is concluded that the biosilica is an excellent material for porcelain industry tiles.

Acknowledgement

The authors thanks to, Mr. R. Elumalai, Govt. Ceramic Institute, for his kind help regarding this work. The authors are grateful and to Mr. Parthasarathy, Managing Director, Orient Ceramic Industry for providing the materials. Thanks are extended to Dr. Krishnan Balasubramaniam, Professor of Machine Design Section, IIT Madras for utilizing ultrasonic pulse velocity facility.

REFERENCES

Amutha K. and G. Sivakumar, 2013. Analytical analysis of synthesized biosilica from bioresidues. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy,* 112: 219–222.

Agenor De Noni Junior, Dachamir Hotza, Vicente cantavella Soler, and Enrique Sanchez Vilches, 2009. Effect of quartz particle size on the mechanical behaviour of porcelain tile subjected to different cooling rates. *J.European Ceramic Society* 29: 1039-1046.

Benneth C. Chukwudi, Patricle O. Ademusuru and Boniface A. Okarie, 2012. Characterization of sintered ceramic tiles produced from steel slag. *J.minerals and materials Characterization and Eng,* 11: 863-868.

Felix Singer and Sonja S. Singer, 1963. Industrial Ceramics. ISBN 81-204-0162-X.

Hessien M.M. M.M. Rashad, R.R. Zaky, E.A. Abdel-Aal, and K.A. El-Barawy, 2009. Controlling the synthesis conditions for silica nanosphere from semi-burned rice straw. *Mater. Sci. Eng. B* 162: 14-21.

Kausik Dana, Sukhen Das and Swapan Kumar Das, 2004. Effect of substitution of fly ash for quartz in triaxial kaolin-quartz-feldspar system. J. *European Ceramic Society* 24: 3169-3175.

Martin-Marquez J., J. Ma. Rincon and M. Romero, 2008. Effect of firing temperature on sintering of porcelain stoneware tiles. *Ceramics International,* 34: 1867-1873.

Ritwik Sarkar, Syamal Ghosh and Swapan kumar Das, 2007. Waste silica from aluminum Fluoride industries used for ceramic whitewares. *American Ceramic Society Bulletin,* 86: 9201-9210.

William M. Carty and Udayan Senapati, 1998. Porcelain-raw Materials, Processing, Phase Evolution and mechanical behaviour. *J. Am. Ceram. Soc.,* 81: 3-20.

****