Comparison Studies of Quartz And Biosilica Influence On The Porcelain Tiles

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Abstract___Vitrification of ceramic tiles was investigated by the incorporation of synthesized biosilica from bioresidue of maize stalk. The fully substitution of biosilica in porcelain formulation augments the strength behaviour and to improve the microstrucutral development. The fired specimens of mechanical parameters such as linear shrinkage, water absorption, porosity, compressive strength and young's modulus were determined. The surface texture of the specimens microstructure development were analysed through Scanning Electron Spectroscopy (SEM). The result that confirms that the biosilica act as a filler in porcelain tiles thus improves the mechanical behaviour of bioceramic tiles than the standard porcelain tiles. The ultrasonic pulse velocity (UPV) of the sintered specimens was correlated with the compressive strength.

Key Words__ Biosilica, Quartz, Bioceramic tiles, SEM, UPV.

1. Introduction

In recent research field, silica plays a vital role such as an adsorbent, catalyst host, pharmacy, drugs delivery, electronic substrate, and filler and so on. Silica is used industrially without being separated into the element, and indeed often with comparatively little processing from natural occurrence. The vast majority of uses for silicon are as structural compounds, either as the silicate minerals or silica (crude silicon dioxide). Silica is an important part of ceramic brick. Silicates are used in making Portland cement which is used in building mortar and stucco, but more importantly combined with silica sand, and gravel (usually containing silicate minerals like granite), to make the concrete that is the basis of most of the very largest industrial building projects of the modern world. Ceramics include art objects, and domestic, industrial and building products.

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Traditional quartz-based soda-lime glass also functions in many of the same roles. Silicon compounds also function as high-technology abrasives and new high-strength ceramics based upon (silicon carbide), and in superalloys.

"Ceramics" refers to any pottery made from fired high-quality clay, silica and feldspar. The ceramics produced are used for a wide variety of applications, ranging from electronic components to sewer-pipes to fine china. Quartz: Silica, SiO_2 is mixed with clay to reduce shrinkage of the ware while it is being fired, and thus prevent cracking, and to increase the rigidity of the ware so that it will not collapse at the high temperatures required for firing. Silica is useful for this purpose because it is hard, chemically stable, has a high melting point and can readily be obtained in a pure state in the form of quartz. However, in the ceramic industry, silica is often obtained from sandstone, which consists of lightly bonded quartz grains. Our investigation is to synthesize biosilica from bioresidue of maize stalk ash using sol-gel route. Hence, the biosilica (BS) was compared with quartz (CS) in the porcelain formulation and characterization was carried out through mechanical parameters and it was correlated with SEM.

2. Experimental Method

2.1 Raw materials

Raw materials of ceramic formulation were choosen and are collected from orient ceramic industry at viruthachalam, Tamilnadu. It was composed by ceramic body 90% (clay 60%, feldspar 30%) and quartz 10%. The oxide composition of raw materials was given in Table.1.

Table.1 Oxide composition of Ceramic Raw Materials materials

Elements	Clay	Feldspar	Quartz
SiO_2	63	63.51	91.53
Al_2O_3	35	13.58	0.85
Fe_2O_3	4.10	0.40	-
CaO	0.28	0.58	-
K_2O	0.32	16.36	-
TiO_2	1.25	0.23	-
Na_2O	0.03	2.96	-
MgO	0.05	0.29	-
MnO	0.06	-	-

The quartz was replaced by synthesized biosilica (BS) from maize stalk ash (MSA) in porcelain formulation. Biosilica was synthesized from extraction of sodium silicate solution. Dilute HCl was added to the above solution and the white precipitated silica gel was obtained. The size of the silica particles was reduced at nano level by refluxing method [5]. From the acid leaching process the purity and amorphous nature of biosilica nanopartilces with the range of 100 nm was obtained.

2.2 Tiles Preparation

Various compositions of materials were weighed and mixed for the tiles preparation in Table .2 which represents 'Qz' the standard material, 'MSC_1' 2.5% , 'MSC_2' 5% 'MSC_3' 7.5% and 'MSC_4' 10% biosilica material.

Table.2 Batch composition of porcelain Materials

Batch	China clay	Feldspar	Quartz	Biosilica
Qz	60	30	10	-
MSC_1	60	30	7.5	2.5
MSC_2	60	30	5	5
MSC_3	60	30	2.5	7.5
MSC_4	60	30	-	10

Each composition was milled in ball milling for 12 h to obtain suitable powdered for further use. The square form (25mm X 25mm X 5mm) tile specimens were prepared by the addition water and pressed using pressing machine. The moisture content of ceramic tiles is about 4-5% is normal [6] and dried for 48 hours and shaping the tiles to attain smooth surface. The dried green tiles are sintered at 1250°C in kiln under controlled temperature and the tiles are tested their quality assessment.

Mechanical parameters such as porosity, water absorption (analytical balance, Archimedes method). The compressive strength (CS) of the fired specimens was recorded by using an universal testing machine (UTM). The morphological characterization of the sintered specimens texture was examined through JEOL JSM 5600LV Scanning Electron Microscopy (SEM) with an Energy Dispersive Spectrometer (EDS) at Annamalai University, chidambaram. The sintered specimens, the time of flight of the longitudinal velocity was measured through Olympus Panametrics-NDT model 5800, IIT madras, Tamilnadu.

3. Results and Discussion

(i) Mechanical parameter

In order to exhibit the property of tiles and their quality assessment has been carried through the mechanical parameters of Linear shrinkage, Bulk density, Water absorption, Porosity and Compressive Strength. From the graph (3.1) indicates a tendency toward lower water absorption and porosity. The significance filler size leads the compactness for density increases and enhances the strength behavior [7].

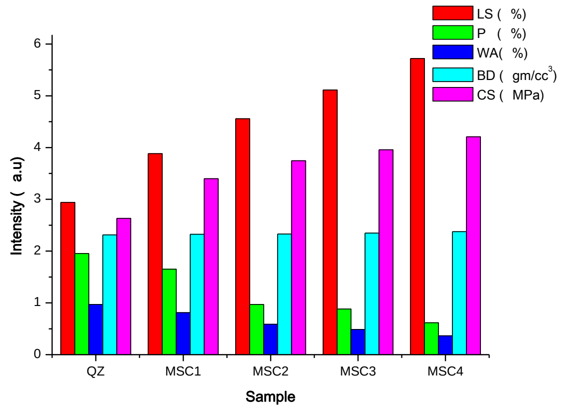

Fig 3.1 Mechanical parameter of Quartz and MSC bioceramic tile

Close porosity starts to increase before open porosity totally disaapears. This vitrification range is achieved when open porosity reaches a minimum value, tending to be nearly zero and simultaneously linear shrinkage is maximum in MSC than the reference one.

(ii) Ultrasonic Pulse Velocity:

The measurement of ultrasonic velocity can be utilized to predict strength and young's modulus of porcelain tiles. This means that when the ultrasonic velocity of a sample is measured, the strength and young's modulus of this sample can be estimated using calibration plots. The results show that when the longitudinal velocity increases, the firing strength also increases [8]. The same condition is observed in the case of shear velocity. By measuring the ultrasonic velocity, the firing strength can be determined. Therefore, the compaction of the material-increase in its density-favors the movement of the ultrasonic mechanical waves, since discontinuities in the interior of the material contribute to waves, affecting the ultrasonic velocity inside the material. There is also a relationship between strength and young's modulus of porcelain tiles.

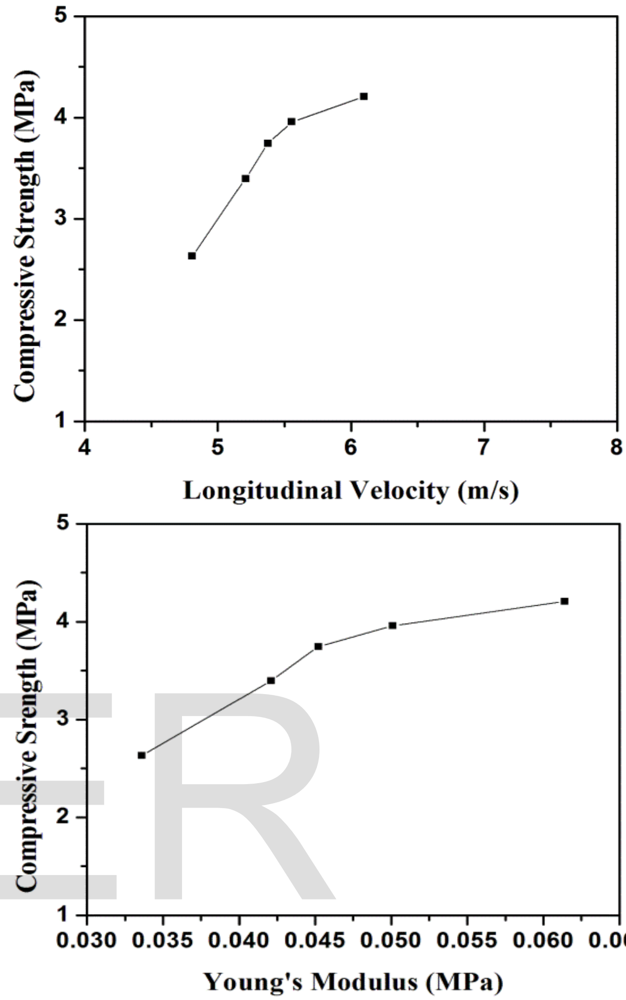

Fig 3.2 Compressive Strength correlated with Velocity and Young's modulus

(iii) Microstructural Analysis

In the micrograph of MSC tiles fig (), identifies the biosilica act as filler in the bioceramic tiles. Nanolevel pores are presented and it represents the low water absorption as well as porosity. The strength behavior was correlated with the closed pores presented. White dotted particles are observed in the micrograph and less pores on the top surface with glassy nature are seen.

From the SEM micrograph of reference tile, at the high magnification of 2K, the rough surfaces with dotted particles are spreaded and the open ores are seen. 5μm and 1μm range of the pores are visualized on the texture and uneven surface also noticed. The open pores which indicate the innerside pore level and the defects were recognizied. 1-5μm diameter and layer formation like seawave geometry are observed in the samples.

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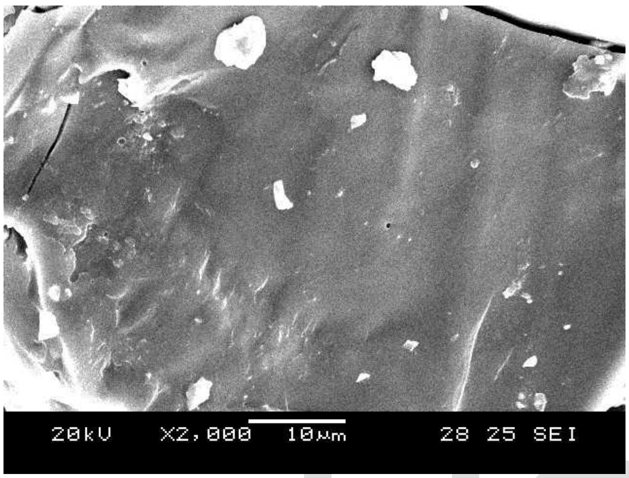

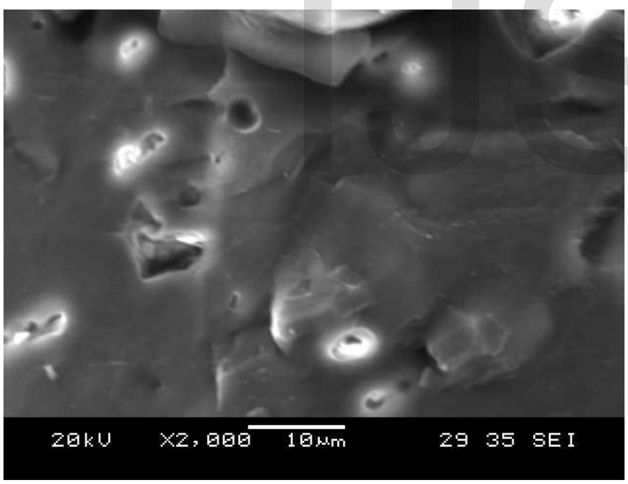

Fig 3.3 SEM image of Reference tile and MSC bioceramic tile.

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