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Effect of Rutile on Modulus of Rupture in Ceramic Glaze

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Abstract

The study was focused on the performance of rutile addition in glaze composition for antibacterial application. Rutile powder in micro size (ξηȝm) were added in the glaze composition at different weight percentage (5 wt%, 7 wt%, 9 wt%, 10 wt% and 15 wt%). Glazing was performed by dipping technique for 10 seconds. Glazed tile was then sintered at 1200°C for 1 hour. Characterizations used to observe the properties of produced tiles were physical observation, scanning electron microscopy (SEM) and modulus of rupture. Results show that cracking occurred in glazed tile which could be related to the viscosity of the glaze mixture during dipping. The relation between viscosity and the occurrence of crack depend on the amount of rutile The amount of crack appearance increases with increasing glaze viscosity. However, modulus of rupture increased when the tile was glazed.

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Keywords: Rutile; dipping technique and ceramic glaze.

1. Introduction

Microorganisms such as bacterium, fungi, protozoa, viruses, etc. commonly infect humans in the living environment[1]. Due the ever growing demand for healthy living, there is a keen interest in materials capable of killing harmful microorganisms[2].Several natural and inorganic materials such as tea extraction, copper, chitosan, zinc and rutile have been used as antimicrobial agents[1].

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Rutile structure has been studied as an antibacterial material and attracted a great deal of attention, because rutile when exposed to ultraviolet radiation below 360 nm generated holes (h^+) and excited electron near its surface, i.e., photo catalysis. The production of active oxygen species such as super oxide and hydroxyl radicals induced from the generated hole-electron pair was effective for the occurrence of antibacterial activity [3]. In this study, rutile was added into the composition of glaze for tile application, the optimum strength of ceramic tile is needed. The ceramic tile has been added with rutile was observed using SEM and Modulus of Rupture.

2. Experimental

The raw materials used in this study were porcelain powder (Fusan Clay & Glaze Sdn.Bhd, Klang, Malaysia), glaze and rutile (micro and nano size)(Sigma Aldrich, Japan). Green porcelain body was prepared by drying a mixture of raw materials at 100°C for 4 hours followed by milling (5 hours) and sieving. The powder obtained was then granulated using 7-8% water, followed by pressing at 110MPa and fired at 1000°C for 1 hour. Green body was thengoing through glazing using dipping method. The prepared glaze was then added with different amount of rutile powder in micro size (ξηʒm) (η wt%, 7 wt%, λ wt%, 10 wt% and 1η wt %) to observe their performance the antibacterial activity. Glazed samples were then sintered at 1200°C for 1 hour.Characterization on the rutile powder was performed by scanning electron microscopy (TM3000 VP FESEM-Supra) to observe the distribution of rutile in the glaze. The modulus of rupture was characterized using Modulus of Rupture Machines (MST433 Macklow-Smith).

3. Results and discussion

Fig. 1 shows the SEM results for the distribution of rutile in the glaze. The distribution of rutile is important to ensure that antibacterial activity will perform on the entire surface of the tile. Fig. 1 (a) show that the 5 wt.% rutile was not homogenous. Parts on the surface, no rutile was observed. This is due to the insufficient amount of rutile used. .Fig. 1(b) shows that the addition of 10 wt.% micro size rutile contributed to agglomeration. The occurrence of the agglomeration might due to the excess amount of rutile used in the sample. The distribution of 15 wt.% rutile in the glaze was shown at fig. 1 (c). Similar to 10 wt.% rutile addition, the addition of higher amount of rutile lead to high agglomeration. Considering the distribution results for 5 wt.% and 10 wt.% micro size rutile, sample with 7 wt.% and 9 wt.% of micro size rutile were produced and observed. Fig. 1 (d) and (e) show the distribution of 7 wt.% of rutile were homogeneous. This how that the rutile was distributed well on the surface. However, the distribution of 9 wt.% rutile was not homogeneous where There can be observed agglomeration on the surface of the tiles. But the agglomeration was less compared to 10 wt.% micro size rutile addition. Result shows that 9 wt.% micro size rutile also not suitable to be use since it leads to agglomeration which show excess amount was used.