UTILISATION OF A LOCAL PEGMATITE IN MATT FLOOR TILE GLAZES

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ABSTRACT

In this study, sodium feldspar, kaolin, quartz and zircon were replaced by a local pegmatite (Bilecik, Turkey) in an attempt to develop matt floor tile glaze formulations. Thermal behaviour of the formulated glazes prepared with and without pegmatite addition was investigated using hot stage microscopy. When the pegmatite ratio was in the range of 5 to 20 wt. %, no significant change in colour and brightness values was observed. In addition, there was no negative effect observed with the pegmatite incorporation on the technological properties such as thermal shock resistance, vapour pressure resistance, resistance to chemicals, abrasion resistance and stain resistance. X-ray diffraction (XRD) was used to analyse the phases formed after firing. Scanning electron microscopy (SEM) in combination with energy dispersive X-ray spectroscopy (EDS) was further employed in order to observe the microstructural characteristics of the selected fired samples. It was concluded that a feldspar type pegmatite raw material of local origin could be used in matt floor tile glazes in as a substitution of currently used expensive raw materials.

1. INTRODUCTION

Ceramic tiles usually consist of two layers. Interior layer has a porous structure composed of sintered mixture of clay, feldspar and silicate particles. On the other hand exterior layer, called as glaze, contains various inorganic materials and covers the ceramic body[1, 2]. In recent years, the production of ceramic tiles with a matt finish has considerably increased. A review of the relevant literature shows that some studies have addressed the causes that produce such finishes and the variables on which these causes depend on[3-6].

The aim of this study was to investigate the possible use of a local pegmatite in place of sodium feldspar, kaolin, quartz and zircon in a commercial matt floor tile glaze.

2. EXPERIMENTAL STUDIES

In order to investigate the effect of pegmatite incorporation on the properties of the commercial matt floor tile glaze (designated as M) used in the company, glaze recipes were calculated based on raw material chemical compositions. Pegmatite ratios of 5, 10, 15 and 20 wt % were used in the recipes (designated as M-5, M-10, M-15 and M-20) to meet the SiO_2 and Al_2O_3 ratio in the standard glaze. As the amount of pegmatite was increased in the recipes, the amounts of Na-Feldspar, Al_2O_3, quartz, kaolin and zircon were reduced accordingly. For the thermal behaviour of the investigated formulations, a hot stage microscope (Mısura 3.0 by Expert System) was employed with a heating rate of 50ºC/min. up to 800ºC and 10ºC/min. up to 1300ºC. The glazes were applied onto a commercial floor tile body with the commercial engobe of the same tile company by spraying. The dried tiles were fired in an industrial roller kiln under single firing condition of 1208ºC for 31min. from cold-to-cold. Qualitative determination of the major crystalline phases present in the fired samples was achieved by X-ray diffraction (Rigaku, Rint 2000, Japan). Microstructural observations of the selected samples were performed on polished using a scanning electron microscope (Zeiss Supratam 50 VP) after sputtering with a thin layer gold-palladium alloy in order to prevent charging. Polishing was carried out in accordance with the standard procedures.

3. RESULTS AND DISCUSSION

Fig. 1 shows the melting behaviour of all the investigated glazes. It is clear that the melting behavior of the pegmatite incorporated glazes is similar to that of the standard glaze. It was measured that the glazes started sintering at around 1130ºC and showed a softening behaviour at 1180ºC.

The crystalline phases present in the glazes were detected using XRD. According to the results, all the glazes showed the presence of the same phases; namely, zircon ($ZrSiO_4$), residual quartz (SiO_2) and anorthite ($CaO.Al_2O_3.2SiO_2$) in similar amounts. The presence of these phases was also detected using SEM (Figs. 2).

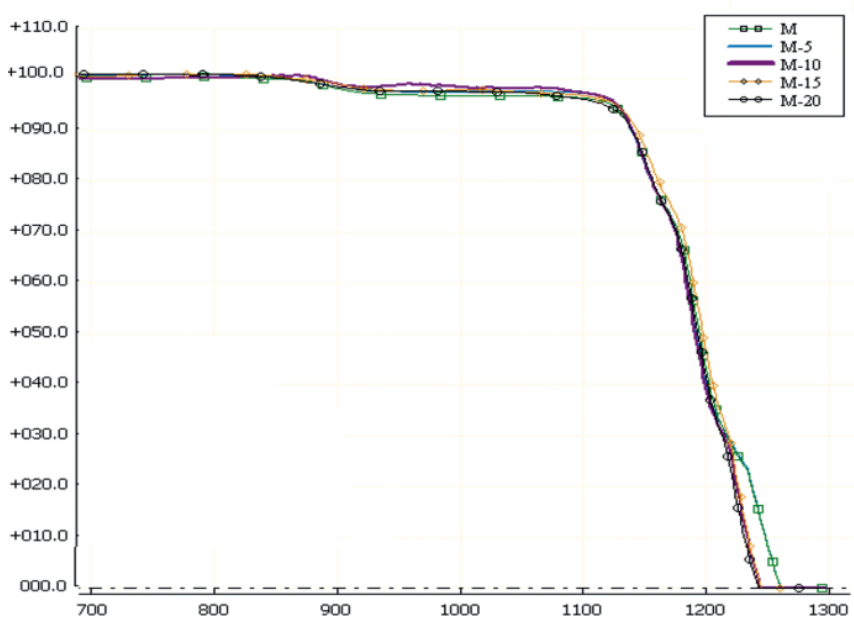

Figure 1. The relation between temperature and area change (%) in the investigated glazes.

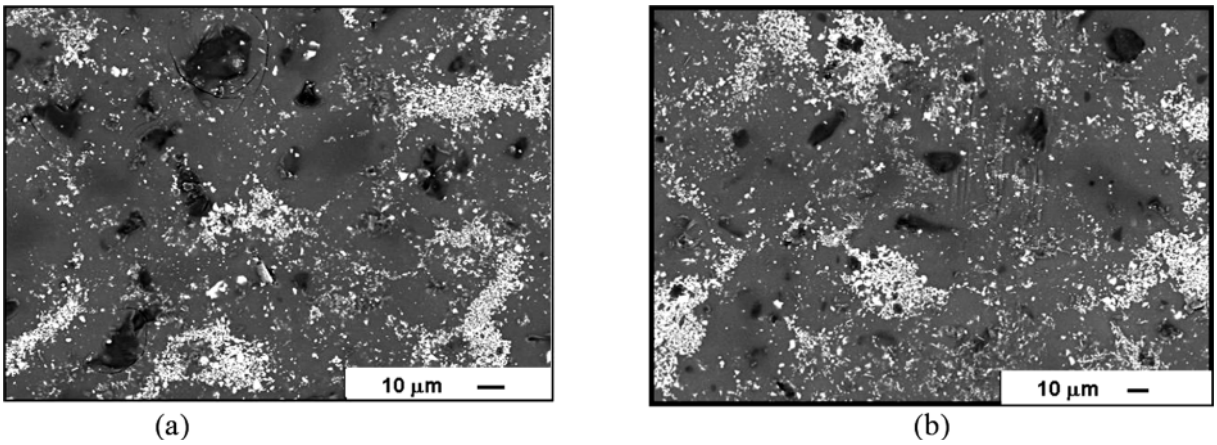

Figure 2. Representative BE images of the standard formulation (M) and wt. % pegmatite containing formulation (M-20). (a) M and (b) M-20

SEM investigation on selected formulations revealed that there was no considerable modification of the glaze microstructure with the incorporation of the pegmatite. In the particular BE images presented above, the areas with high contrast distributed randomly in the gray glaze matrix indicate the presence of zircon crystals. The dark areas are believed to be the unmelted quartz grains. Finally, the light gray phases are assumed to be the anorthite grains. The EDX was also employed to confirm the presence of relevant elements.

4. CONCLUSIONS

The results of the present study showed the possible use of a feldspar type local pegmatite in a commercial matt tile glaze in a controlled manner in order to induce similar degree of crystallization. It is expected that such use will bring cost savings to the company. However, before proceeding any further with industrial trials, the

mechanisms of crystallization need to be further investigated and compared in detail in both the commercial and the pegmatite containing formulations.

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