

EFFECT OF THE USE OF GLASS FROM MINING WASTE ON GLAZE PROPERTIES

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ABSTRACT

A study was conducted on glaze compositions based on mixtures of a transparent frit and glasses from Ni-Cu-Co mining waste. The glasses were also fritted and wet milled to a size smaller than 50 μm . Frit-glass mixtures were prepared with 5, 10, 15, and 20% glass by weight and fired at 1100°C. The mechanical and optical properties of the resulting glazes were determined and correlated with the glass concentration in the mixture, as well as with the presence of minor elements in the glass. Since the glass from mining waste formed crystalline phases of the augite type at temperatures close to 910°C, the percentage of glass in the glaze notably influenced the microhardness. The glaze exhibited no important crystallisations at percentages of 10%, whereas these became very significant at values of 15 and 20%.

1. INTRODUCTION

The cost of raw materials for obtaining glazes with interesting properties has grown in recent years, particularly owing to energy and transport problems [1]. The use of inert industrial wastes as raw materials, in addition to the low cost, would notably reduce the environmental impact. One type of waste that could be appropriate as raw material is the waste generated in Ni mines. In addition to Ni, this waste contains a certain percentage of Cu and Co, all mixed in a clay with a high iron content. The study conducted here was based on preparing a glass from this waste and then mixing it with a transparent frit to obtain glazes and to analyse their feasibility as a new source of alternative raw material.

2. EXPERIMENTAL

A transparent frit (designated FTQ14) was used, together with a fritted glass (designated Mina), obtained from mining industry waste, with the following composition by weight: SiO_2 (46 %), Al_2O_3 (17%), Fe_2O_3 (10%), MgO (13%), CaO (12%), Na_2O (1%), and NiO-CuO-CoO (1%). Using both materials, slips were prepared in percentages of 0, 5, 10, 15, and 20% Mina glass by weight (these percentage are indicated in the references of each sample). Homogenisation was performed in a grinding mill, followed by sieving to a size $<50\text{ }\mu\text{m}$. The slip was deposited on a red-body biscuit and the glazes were subjected to firing in a conventional cycle at the same peak temperature for every glaze. The samples were characterised by X-ray diffraction (XRD), differential thermal analysis (DTA), Vickers microhardness, gloss, and colour.

3. RESULTS AND DISCUSSION

Figure 1 and 2 shows the DTA curves of the frit-Mina glass mixtures and the XRD curves of the mixtures after the firing cycle. In the DTA curves, it may be observed that, above 15% Mina glass, the exothermic peak at about 900°C reveals that glaze crystallisation began to become significant. The XRD curves show the presence of the crystalline phases augite, mullite, and quartz starting at 15% Mina glass [2].

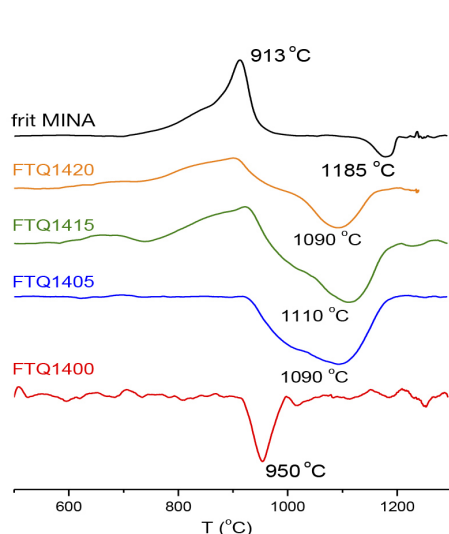


Figure 1. DTA of FTQ14 – Mina glass.

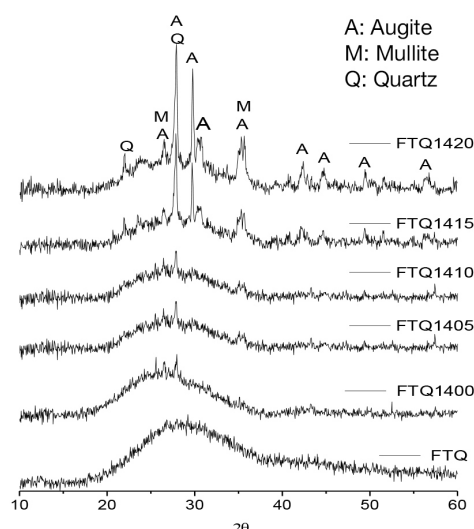


Figure 2. XRD of FTQ14 – Mina glass.

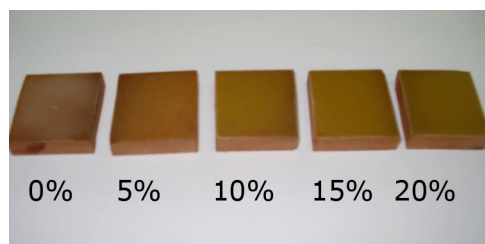


Figure 3. FTQ14 – Mina glazes.

% Mina	0	5	10	15	20
L	51	47	49	50	49
a	9.6	11.1	9.3	9.1	8.0
b	9.9	16.6	23.3	25.0	23.1
Gloss 60°	11	4	9	5	3
Hv (GPa)	8.1	8.7	9.0	9.6	9.6
E (GPa)	78	85	87	91	92

Tabla 1.- Propiedades de esmaltes FTQ14-Mina

Figure 3 shows a photograph of the resulting glazes and Table 1 details their properties. It may be observed that when the Mina content increased, coordinate b increased from 10 to 25, while L and a remained steady; gloss decreased, whereas hardness and the modulus of elasticity increased. These variations may be attributed to the incorporation of transition metals from the Mina glass, particularly Fe, and to the crystallisation of quartz and phases of the pyroxene type.

4. CONCLUSIONS

The incorporation of percentages of glass from mining waste into a transparent frit led to the crystallisation of augite and quartz and improved the mechanical properties of the glazes, while coordinate b increased at the same time from 10 to 25. Crystallisation appeared at contents of 15% or more Mina glass.

REFERENCES

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