DEVELOPMENT OF NEW CERAMIC GLAZES FOR METAL WITH LOW ENERGY COST

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1. ABSTRACT

In this study, a new glaze was developed for application on metal with an appropriate substrate–coating fit, yielding defect-free, perfectly enamelled pieces with improved physical and chemical properties. Using compositions based on ceramic glazes with a fritted composition, the energy consumption of the firing stage was reduced, as the firing temperature was lowered.

Both transparent and opaque glazes were then developed for application in enamelling copper plate, obtaining good results in application and firing. The formulated glazes were then coloured [3] with different colorants: natural oxides and ceramic pigments, obtaining two very wide-ranging colour palettes, as well as different glossy and matt finishes.

Finally a chemical, physical, and microstructural characterisation, as well as a study of the aesthetic properties, was performed of all the coatings.

2. INTRODUCTION

Applying glaze on metal is a very widely used technique, but the glazes involved are very expensive, as few companies manufacture them.

The general aim of this study was to develop a glaze composition that provided an appropriate fit between the substrate and the coating [2], yielding defect-free, perfectly enamelled pieces, with improved physico-chemical behaviour. Commercial ceramic glazes with a fritted composition were used and a significant reduction in firing temperature was achieved, which translated into lower energy consumption in the firing stage.

3. EXPERIMENTAL AND RESULTS

The study was conducted with ceramic glazes containing a fritted composition, which are used for porous tile bodies, and with commercial glazes for metal.

First, the compositions of different commercial glazes for metal, as well as of two ceramic glazes: a lead borate glaze, EBP, and another lead glaze EP, were determined by chemical analysis (Table 1). Glaze EBPF was formulated for metal (Figure 1 and 2), based on the compositions of glazes EBP and EP [1].

	EBP	EP	EBPF
	no. of moles	nº of moles	nº of moles
SiO_2	0.5	1	1.22
B_2O_3	1.51	-	0.3
PbO	1	1	1

Table 1. *Seger formula of the commercial ceramic glazes and of the glaze formulated for metal (EBPF)*

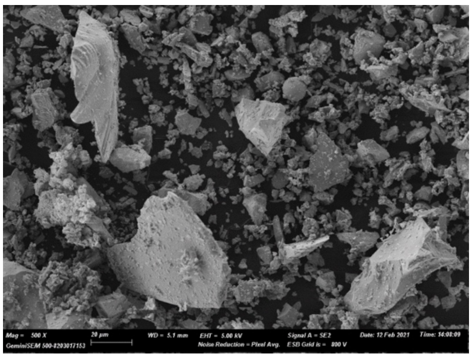

Figure 1. *SEM image. EBPF (4000x)*

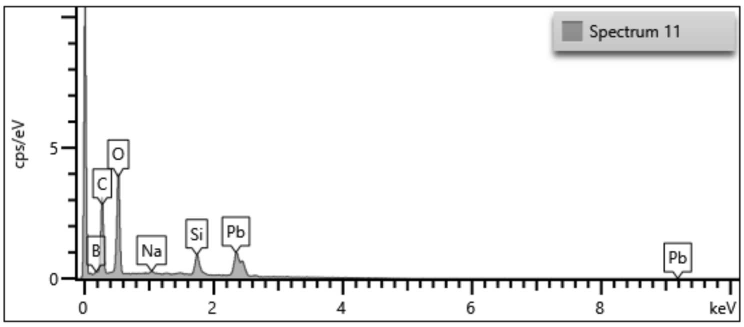

Figure 2. *EDX image of glaze EBPF.*

Particle size analysis of the different glazes in Figures 3 and 4 showed that the particle size of the formulated glaze EBPF was smaller than that of the commercial glazes EM1 and EM2. This meant that it would be possible to lower glaze firing temperature [4], as was experimentally confirmed.

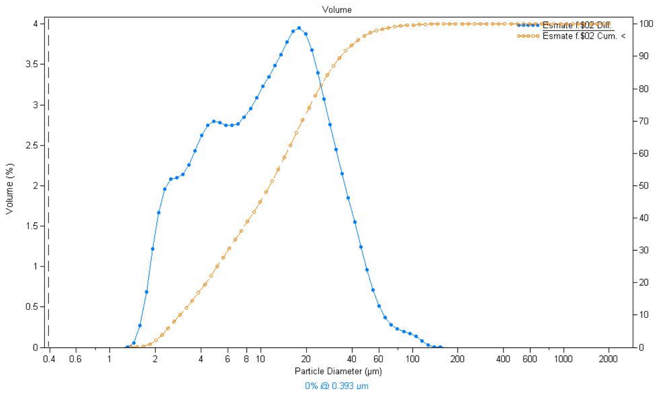

Figure 3. *Particle size analysis of glaze EBPF1*

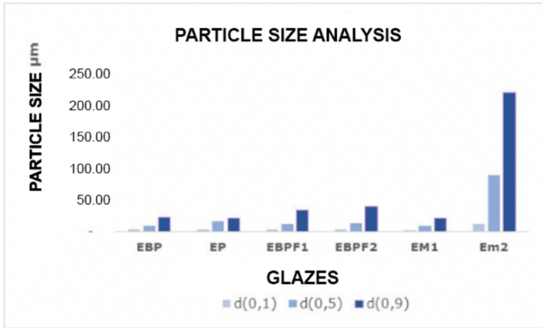

Figure 4. *Study of glaze particle sizes. (Ceramic glazes EBP and EP; formulated glazes EBPF1 and EBPF2; and commercial glazes for metal EM1 and EM2).*

Figures 5 and 6 depict the different coefficients of expansion. The formulated glaze EBPF2 (opacified with 3 wt% zirconia) was observed to be the glaze that most closely approached the coefficient of expansion of the metal plate, which meant a better fit.

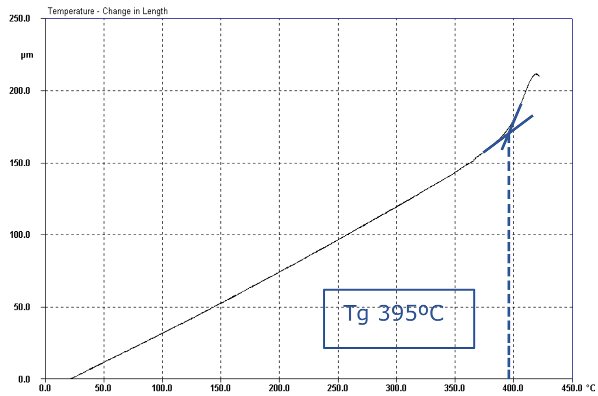

Figure 5. *Dilatometric plot of glaze EBPF.*

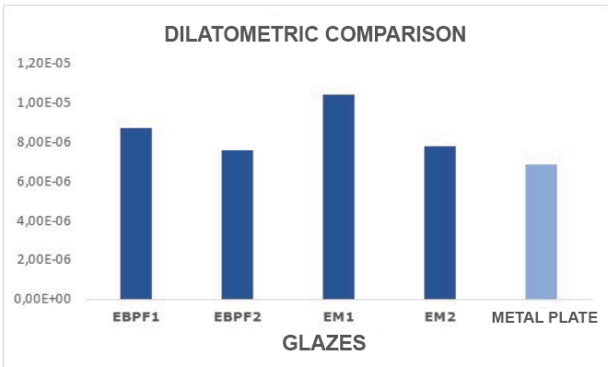

Figure 6. *Comparative study of the different coefficients of expansion*

Higher gloss and higher Vickers hardness (269.85HV) were obtained than with the commercial glazes for metal.

Transparent glaze EBPF1 was then coloured with commercial ceramic pigments with 5 wt% additions and the glaze was opacified with zirconia, obtaining different colour palettes.

Figure 7: *EBPF1+ pigments at 5 wt%.*

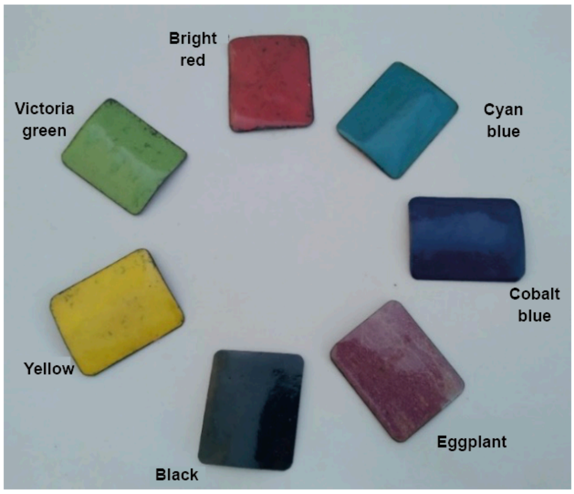

Figure 8: *EBPF1+ 3 wt%* ZrO_2 and *pigments at 5 wt%.*

4. CONCLUSIONS

The new use of lead borate ceramic glazes, with a low temperature, in the glaze formulation for application on metal, enabled improvement of the fit and of the hardness, gloss, and colour development properties, compared to those of commercial glazes. The new composition, together with the smaller particle size of the formulated glaze, have in addition allowed the firing temperature to be lowered by 15%, reducing energy consumption in the firing process.

5. REFERENCES

[1] Bonski, R. P. "The Effect of Zirconite Dissolution on the Color Stability of Glazes", Ceram. Eng. Sci. Proc., 15 [l], y 249-265, 1994.

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