MATTING OF A TRANSPARENT POROUS WALL TILE GLAZE BY ADDING ALUMINA

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1. INTRODUCTION

The use of alumina as an additive in glazes has an important effect on the technical and aesthetic characteristics of the resulting glaze. One of the most common aesthetic effects achieved with these raw materials is the so-called matting effect. This is caused by the surface roughness of the glaze, which is not visible to the naked eye, but is sufficient to produce multiple reflections of impinging light and entailing loss of gloss.

The behaviour of a given alumina in the glaze composition is known to depend on alumina physical characteristics (specific surface, particle size, etc.) which in turn mainly depend on the material's degree of calcining during preparation. Raising calcination temperature increases the proportion of (-alumina, which is the high-temperature polymorph, while at the same time increasing primary particle size and reducing specific surface.

In the present work, a study was undertaken of the degree of matting attained when aluminas with different physical characteristics are added to a porous wall tile glaze.

2. MATERIALS AND EXPERIMENTAL DEVELOPMENT

Four aluminas (A, B, C and D) with quite different characteristics were selected, which are currently used in ceramic glaze production. Another alumina, alumina B_{bis} was prepared from B by dry milling for 60 min. Table I details some of their most important characteristics.

Characteristic	A	B	B_{bis}	C	D
Particle size, D50 (μm)	100	90	8	75	20
Primary crystal size, D50 (μm)	0.5	0.8	0.8	3	8
Specific surface (m^2/g)	60	12	13	0.5	0.2
Major polymorph	γ	α	α	α	α

***Table I.** Physical characteristics of the studied aluminas.*

A glaze was prepared with each studied alumina, according to the following composition: 12.5% alumina, 80% transparent fast single-fire frit and 7.5% kaolin. The glaze compositions were airbrushed onto porous wall tile bodies and subsequently fired at a peak temperature of 1140°C for 6 min. Resulting glaze gloss was determined and glaze microstructure was examined by scanning electron microscopy.

3 RESULTS

Figure 1 plots the effect of alumina specific surface on resulting glaze gloss on semilogarithmic coordinates. The figure reveals that gloss varied from percentages below 20‰ (usual value for a matt white glaze) to percentages approaching 90‰ (standard value for a glossy white glaze), while this parameter rose as the material's specific surface decreased.

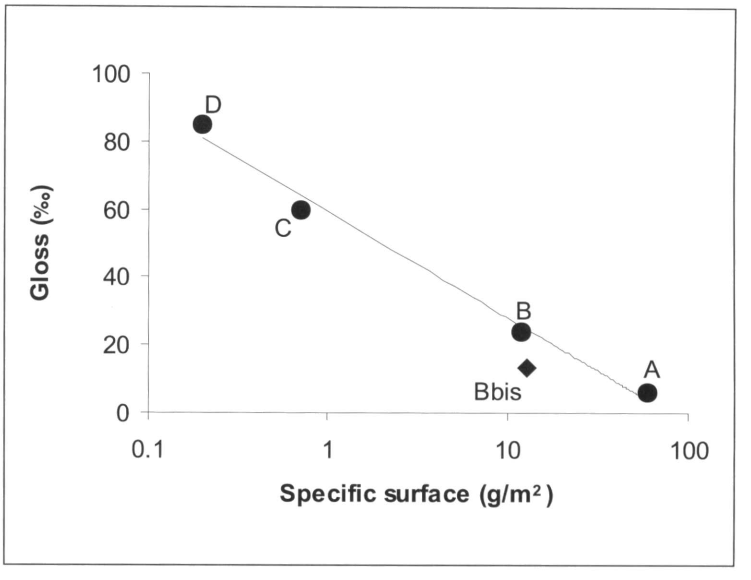

***Figure 1.** Relation between gloss and alumina specific surface..*

Electronic microscopy helps explain this behaviour. Observation of the glaze microstructure reveals that alumina particle dissolution in the glassy matrix rose as particle specific surface increased. Thus, in the glaze made up with alumina A, no crystalline particles were observed because these had dissolved completely. However, in the glaze produced with alumina D, crystalline particles were found with a size similar to that of the primary or single crystal, which indicates that they had barely dissolved.

The matt effect is normally considered to stem from the surface roughness produced by undissolved crystalline particles. However, according to the findings, the matting mainly depended on glaze viscosity. It was found that the larger the amount of dissolved alumina in the glassy phase, the higher was melt viscosity. This caused the texture of the unfired glaze to be kept after firing, it being this roughness which produced the gloss loss found.

On the other hand, when aluminas with a very low specific surface were used, glaze "stretching" was greater, so that even though crystalline particles remained undissolved, surface roughness was not great enough to produce significant gloss loss. Thus, in these cases, larger alumina contents are required to produce the same effect in the studied glazes as the effect found with materials having a greater specific surface.

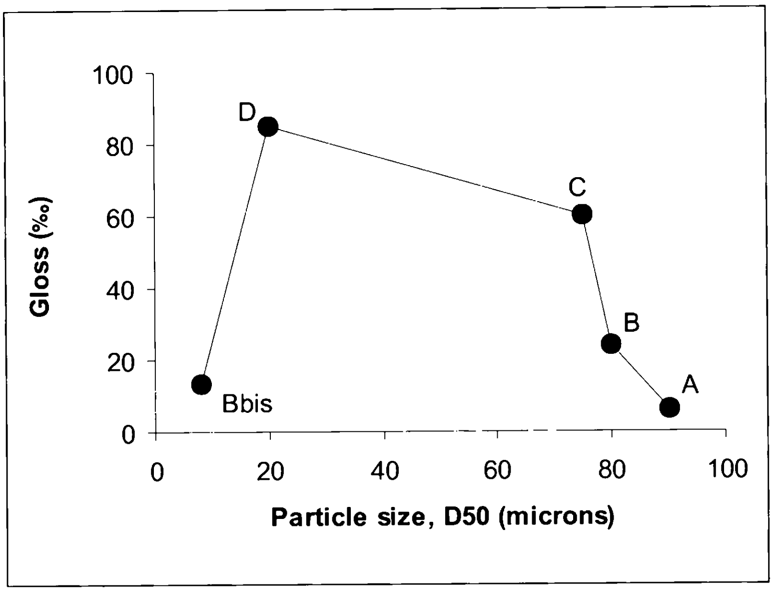

Figure 2. Relation between gloss and mean alumina particle size.

On the other hand, one of the physical characteristics traditionally considered a determining factor in alumina behaviour is particle size. Figure 2 plots gloss versus mean particle size D50. The figure shows no close relationship between these parameters.

The findings can be explained by bearing in mind that alumina particles are agglomerates of relatively soft primary crystals, so that during glaze preparation, these agglomerates are milled to sizes close to single crystal size. It therefore appears to be this size, directly related to specific surface, and not the particle or agglomerate starting size, which determines the greater or lesser matting effect.

However, though particle size should not decisively affect matting, re-examination of Figure 1 shows that alumina B_{bis}, obtained from B, exhibited slightly lower gloss than B. This fact can again be explained by considering the greater alumina dissolution in the glassy phase, and hence higher viscosity in the molten glaze. In effect, the preliminary milling that B_{bis} underwent was more vigorous than when alumina B was milled together with the other glaze batch constituents, so that the resulting particles were smaller and therefore more reactive, dissolving more readily and raising melt viscosity.

4. CONCLUSIONS

A study was undertaken of how aluminas with different physical characteristics affected matting in a transparent glossy porous wall tile glaze.

Glaze gloss was found to decrease as specific surface, and hence alumina reactivity and dissolution in the glassy phase, rose. These findings are explained by assuming that the rise in viscosity discourages the elimination of the unfired glaze texture during firing, this roughness being the main cause of the resulting gloss loss.

Matting was encouraged on reducing particle size. However, this parameter was not as critical as alumina specific surface.