THE INFLUENCE OF THE AVERAGE PARTICLE SIZE OF ZIRCON ON ITS OPACIFYING CAPABILITY IN CERAMIC GLAZES

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The opacifying capability of the zircon depends on several characteristics such as the chemical and mineralogical composition, the mean particle size and size distribution, etc. Mie's theory describes the effect of the average particle size of the opacifying phase on the diffuse reflectance in glasses and suggests that, for zircon dispersed in a window glass (n = 1.5) the average diameter of 0.7μm should produce the maximum opacity. If this prediction is valid, it would simplify considerably the life of many ceramists all over the world. However, the development of Mie's theory required many assumptions that may not be always valid and may compromise the general validity of its predictions. Also, it's important to take into consideration two practical aspects: 1) the costs of producing such a fine particle size are quite high and 2) the decrease of the particle size would increase the probability of the zircon particles dissolving into the glaze[1,2,3]. The main objective of the present work was to evaluate the influence of the average particle size of zircon on its opacifying capability. To achieve this, samples of six commercial zircons, from different sources and countries, were used. After the samples were fully characterized, they were ground to produce samples with different average particle sizes. The opacifying capability of the different samples was comparatively evaluated, against a standard, through the measurement of the colorimetric coordinate L*, by a spectrophotometer, in glazed surfaces produced by the standard procedure. The glazing conditions were studied to avoid the interference of the colour of the bodies. Through the analysis of the results a standard experimental procedure, mentioned above, was established. The influence of the zircon content and the maximum firing temperature, on the opacifying capability of the samples, also was evaluated.

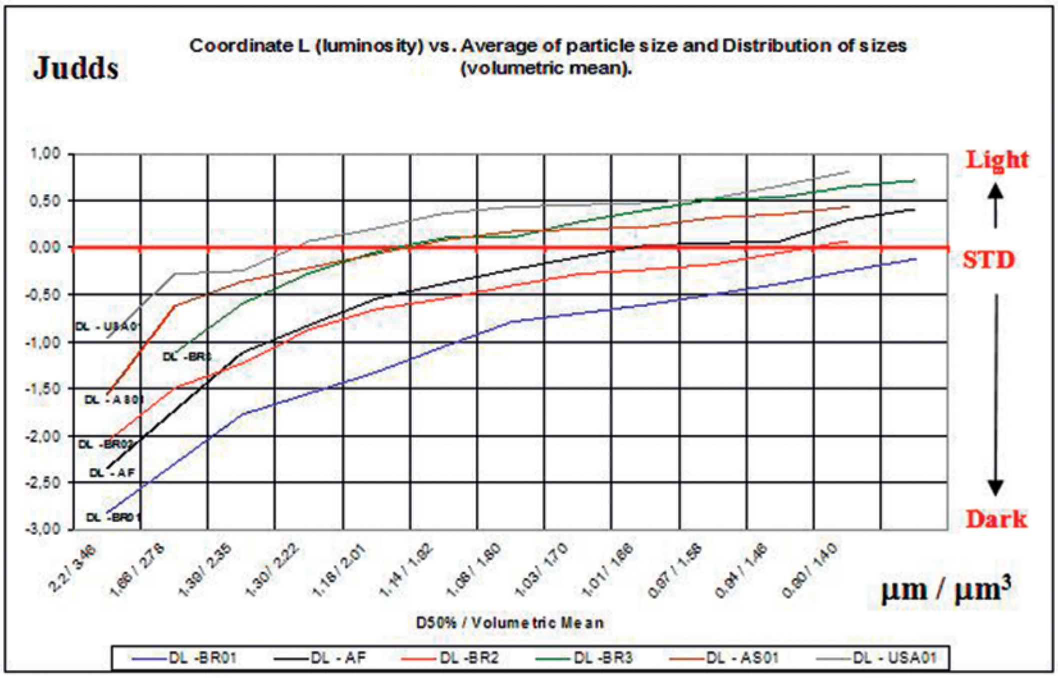

Figure 1. Coordinate L vs. average of particle size (D50%) and volumetric mean (M.V.) of 06 zircons compared to a commercial standard.*

The influence of the variables mentioned above on the other colorimetric coordinates, a* and b*, were also recorded.

The results have shown the profound influence of the average particle sizes of the zircon samples on their opacifying capability. The general behaviour of the curves representing the values of relative L* versus average particle size was similar and L* increases with the decrease of the average particle size for all samples. However, the position of the curves corresponding to the different samples has varied considerably indicating that it's not a good practice to fix a particle size value for zircons with different characteristics. As follow the Table 1 is one example of the comparison of two zircons that present about the same value of luminosity (L* coordinate) and very different results in the average of particle size and size distribution.

Index	µm³	Channel	µm	Channel	µm
mv =	1.982	10% =	0.412	60% =	1.603
mn =	0.429	20% =	0.568	70% =	2.345
ma =	0.921	30% =	0.734	80% =	3.379
cs =	6.511	40% =	0.920	90% =	4.795
sd =	1.689	50% =	1.172	95% =	5.932

Index	µm³	Channel	µm	Channel	µm
mv =	1.369	10% =	0.384	60% =	1.138
mn =	0.429	20% =	0.492	70% =	1.543
ma =	0.776	30% =	0.609	80% =	2.180
cs =	7.731	40% =	0.741	90% =	3.064
sd =	1.020	50% =	0.904	95% =	3.830

Table 1. Particle size distributions of zircons USA-01 and BR02 respectively.

The results of the study of the effects of the content and maximum firing temperatures, on the opacifying capability, also have varied considerably from sample to sample. As expected, the increase in the zircon content led to higher opacities for all samples, however, the amount required to achieve the opacity of the standard zircon varied considerably. The increase of the maximum firing temperature resulted in a decrease of the values of L* and, as for the average particle size, the curves presented a similar shape however their positions varied considerably. In summary, the findings of the present work have shown that it's wise to evaluate properly the opacifying capability of every zircon to determine the appropriate amount and average particle size to optimize it's performance and that the use of fixed values for these parameters could have significant performance and economic implications.

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