Microwave versus conventional porcelain firing: the effect on the colour

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Porcelain undergoes several transformations during firing with associated colour changes, which depend mainly on the impurities of the raw materials, the surrounding atmosphere, and the firing temperature. During the process of firing, the raw materials are subjected to a set of chemical and physical transformations, with mullite, quartz and a vitreous amorphous phase being the main constituents of the fired ware. Some transformations are responsible for colour changes, such as the kaolinite dehydroxylation that starts at around 450 °C – 600 °C, depending on several factors such as its order-disorder state. The heating technology also seems to affect the ware's colour. Microwave heating technology is an alternative firing technology, without compromising the porcelain quality and mechanical performance, with gains in the manufacturing time and energy efficiency, having lower emission of pollutant gases when used in the manufacturing of such products.

This work analyses the colour of microwave and electrically fired samples from room to temperatures up to slightly above 1400 °C, and compares their colours with that of the reference samples gas fired. Below 1100 °C, the colour of the microwave fired samples is within the green-blue spectra, and the colour of the electrically fired samples is within the yellow-red spectra. Above 1100 °C, and up to 1400 °C, the colour of the microwave fired samples converge to the yellow-red spectra, as to the colour of the reference samples. Microwave heating promotes faster crystallochemical transformations, occurring at lower temperatures, responsible for the colour differences, especially for firing temperatures below the porcelain's eutectic temperature. This study aims to a better understanding of microwave porcelain firing, focusing on the reasons behind the observed colour differences when compared with conventional firing.

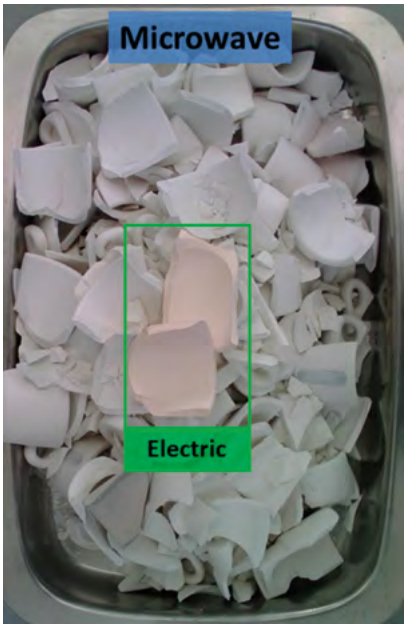

FIGURE 1
Fragments of samples fired in the microwave and electric furnaces.

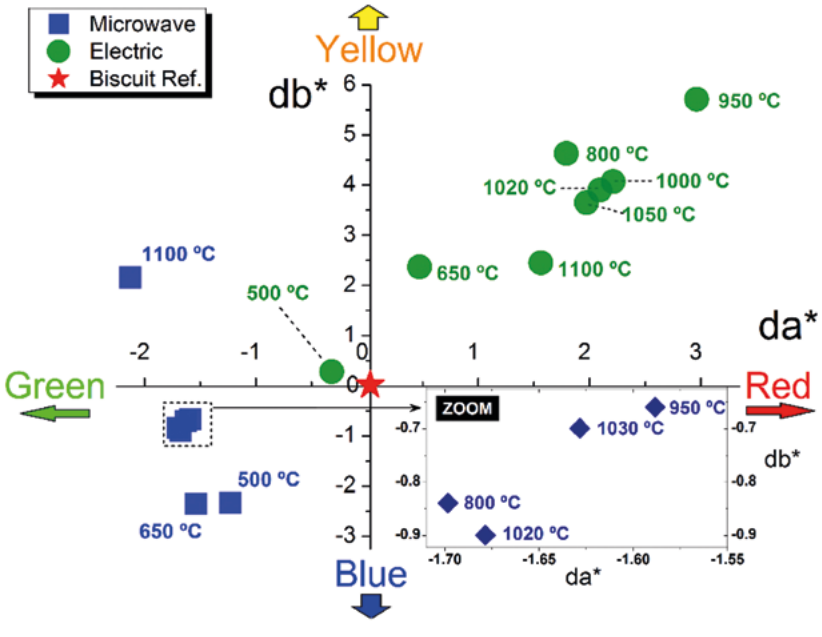

FIGURE 2
Space colour coordinates (a* and b*) relative to the biscuit reference sample. Samples fired up to 1100°C in both microwave and electric furnaces are presented.