# Micronization of ceramic colorants. From understanding to energy efficiency of the process

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With over 16 billion m$^2$ worldwide, in 2020 the ceramic industry marked a new record in tile production (Baraldi, 2021). Similarly, the global demand for ceramic pigments and dyes (ceramic colorants), driven by the ceramic tile industry, has also grown rapidly in the last decades leading to a growing need for raw materials and energy.

Nowadays, inkjet printing (IJP) with micronized inks has become the decoration technology par excellence for ceramic tile (Molinari et al., 2020). Through this technology, the finished product is no longer a powdered colorant, but a micronized colorant dispersed in a carrier, i.e., an ink that undergoes a high-energy stirring milling process where particles must have a median size ($d_{50}$) of ~300 nm to fulfill IJP requirements (Hutchings, 2010).

Being mainly dependent on the specific energy input (i.e., the energy supplied to the grinding chamber per mass of product), pigment micronization down to the requested particle size proves to be the most energy-consuming comminution process per unit weight of product (Wang & Forssberg, 2007). It follows that comminution of ceramic colorants is a key issue for ink production, which has strong repercussions on color strength, mechanical properties and resistance to amorphization of the colorants' crystal structure, as well as on the energy management of the entire process. On the other hand, a deep understanding of the comminution dependence on many of these aspects is still lacking.

In this contribution, the micronization effects on a set of five industrial ceramic colorants are thoughtfully investigated through a simulation of the industrial process at a pilot plant, where particle size distribution and energy consumption are monitored during the comminution process.

The combined analytical approach (i.e., X-ray diffraction, scanning electron microscopy, and diffuse reflectance spectroscopy) aided by a physical/semiempirical modelling of the colorants' elastic features versus the energy response of the particle reduction has yielded details on the nature of the micronization-induced microstructural changes in ceramic colorants.

The results obtained represent a fundamental development towards the optimization of the comminution process. A proper energy modulation allows to limit harmful emissions and save raw materials.

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