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Actual resolution in ink-jet printing of ceramic tiles: preliminary assessment of imprint size under different operating conditions

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The behavior of ceramic inks during jetting by drop-on-demand piezoelectric devices is well-known, being investigated in detail by watchdrop observation in the setup of every ink-jet printer. In contrast, the behavior once the ink drop touches the substrate is to a large extent unknown. In particular, no data are available about the effect on the printing resolution of drop impact, ink spreading and penetration into the porous raw glaze. This behavior is affected not only by the ink density, viscosity and surface tension and by the settings of the printing heads, but also by the speed of the tiles on the conveyor belt and, presumably, by roughness, porosity, wettability and permeability of the glaze layer.
In ceramic tile decorationthe image quality is usually checked by both qualitative observation (e.g., Altona Test Suite) andquantitative colorimetric measurements (by using testcharts). However, these tests are not able to discriminate the effect on the image quality due to drying and firing from that due to phenomena occurring prior the heat treatment. In order to fill this gap, this work will examine the post-jetting behavior of ceramic inks and particularly what happens to ink drops after impact, spreading and penetration (through observation of imprints on the raw glaze surface) as well as after drying and firing (through observation of colored dots on the finished product).
The ink-jet printing was carried outwith an industrial plotter (equipped with a Dimatix StarFire print head) under different conditions: drop volume (30, 50 or 80 pL); printing mode(single binary or grayscale); surface coverage (5% or 10%). Two sets of industrial ceramic inks (cyan-magenta-yellow-black) were used: oil-based (OB) and water-based (WB), i.e. with polar carriers. Two different industrial substrates were printed: raw glaze and unglazed raw body. Imprints were characterized by estimating size, area, perimeter, and roundness by image analysis of photos taken under an optical microscope. From these data it was possible to calculate the spreading index(the imprint area to drop equatorial cross section ratio) after both ink applicationandheat treatment.
The resultsshow, for the first time, that the imprint of ceramic inks is far away from the ideal circular shape, having anirregular outline and suffering from a remarkable shrinkage during firing. Sometimes, a "coffee stain" effect is appreciable as empty imprints, more common in the case of WB. Furthermore, the spreading index varies significantly from OB to WB inks and it isapparently function of the drop size.The impact of drops appears to be similar inOB and WB, which exhibit analogous values of spreading index. However, a difference is introduced by the heat treatment, resulting in a higher spreading index of WB inks. The inks spread more on the unglazed body, both after decoration and firing, likely because the glaze layer is more porous than the unfired porcelain stoneware body. Future work will be addressed to set up an experimental protocol to characterize the image quality and actual ink-jet printing resolution on ceramic tiles.

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