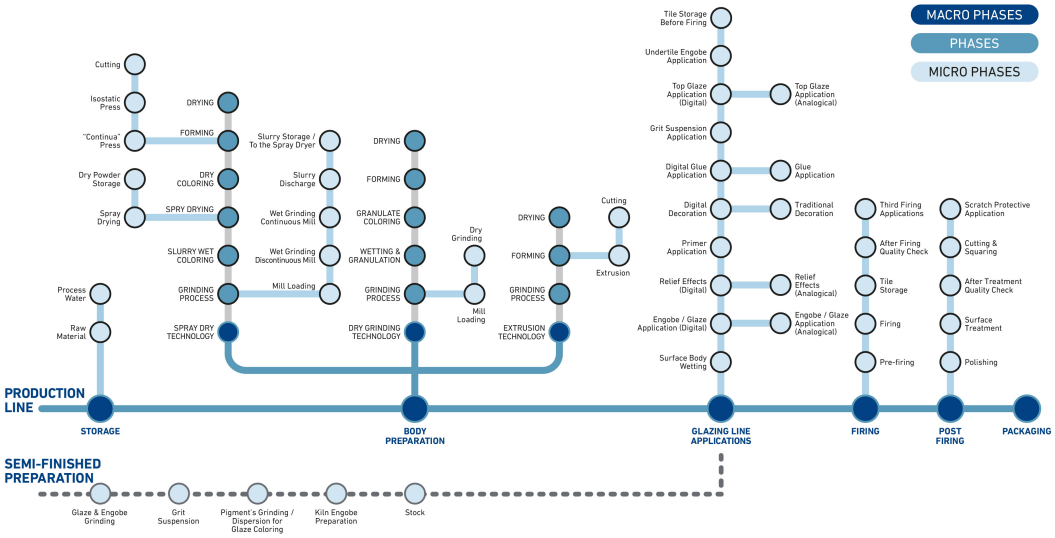
ZSCHIMMER & SCHWARZ
CERAMCO

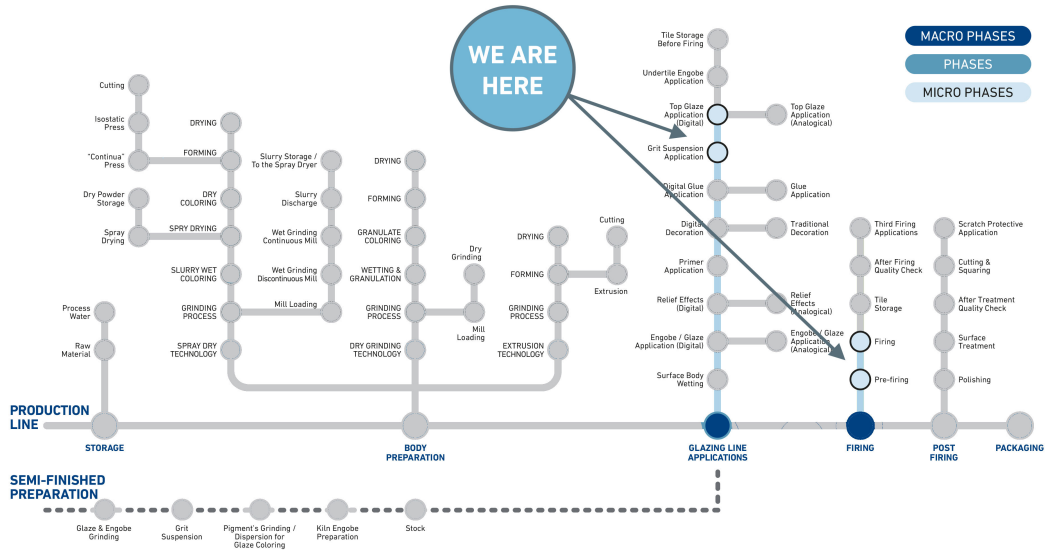
APPARENTLY INVISIBLE YET CONSTANTLY PRESENT

At every stage of the ceramic production process

A journey through problems & solutions



#08 SUPERFICIAL PIN-HOLES AFTER FIRING: CAUSES & REMEDIES



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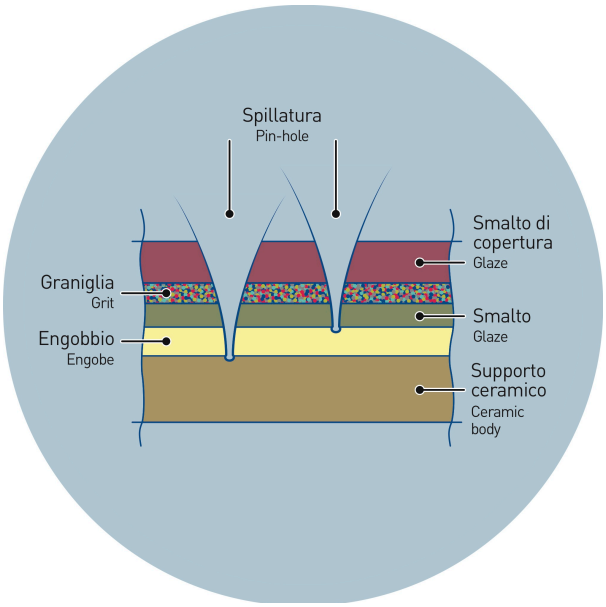
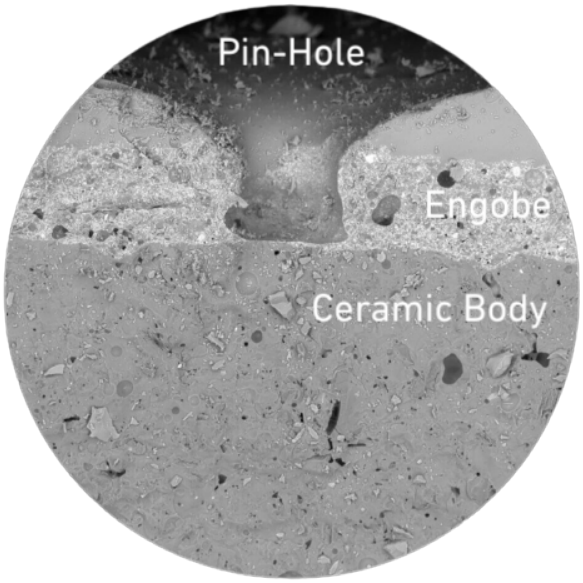
After the early phases of the ceramic production process, such as the forming and the shaping of the ceramic body as well as of all applications that take place along the glazing line (from the engobe application to the decoration step by means of digital printing machine), the process involves a final application of grit or glaze, sometimes in significant amounts.

Of course, if you do not meet the proper parameters this application – that occurs just before the firing process – can sometimes lead to different kind of problems that may compromise the ceramic surface, both technically and aesthetically.

Among the several defects that may arise, the appearance of almost invisible holes - or **pinholes** - that can be localized or spread all over the surface is the most significant.

The roots of the problem are many but the most important must be found not only inside the kilns but also – and above all – in all that stages that come before the firing process: especially along the glazing line.



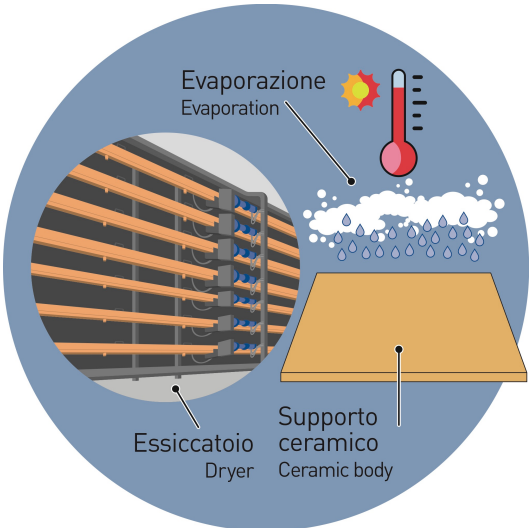


Let's try to point out the core scenarios.

1. TEMPERATURE AND IMPROPER APPLICATION'S DRYING PROCESS

The first to consider is the temperature of the ceramic material as it leaves the dryers.

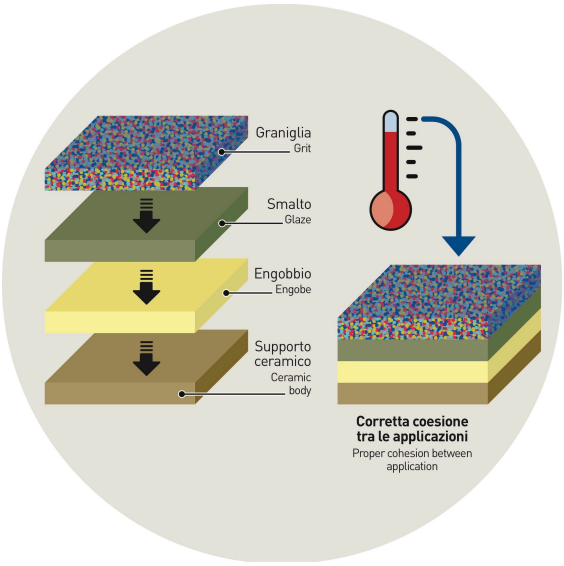
Reminder: inside the dryers, and before entering the glazing line, green tiles are still marked by a residual humidity that can range from 5% to 7% and this is the reason why they must undergo to a thermal cycle to reduce the humidity to a value that is around zero and therefore to avoid problems during the final firing process.



When they leave the dryers, **tiles must have a relatively high temperature.**

Why?
Because the high temperature ensures a better development of all those applications that later follow along the glazing line, thanks to the loss of their water content through the evaporation process.

What does that mean?
The evaporation process promoted by the high temperature of the tile, makes the surface dry and therefore ready to properly receive the subsequent applications since the presence of excessive water instead of promoting a proper cohesion between the applications discharged on the tile surface could sometimes lead to a mix – or a blending of the layers
And this, obviously, is a serious problem.



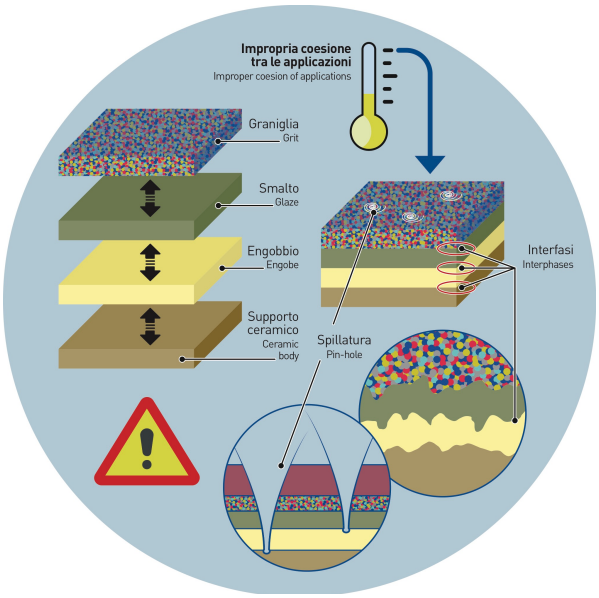
Nevertheless, we must also add that it is important to keep just a little of humidity to promote a proper application and cohesion of the different layers. Just like a cake.
It's therefore clear that we are talking about a very delicate and never constant balance.

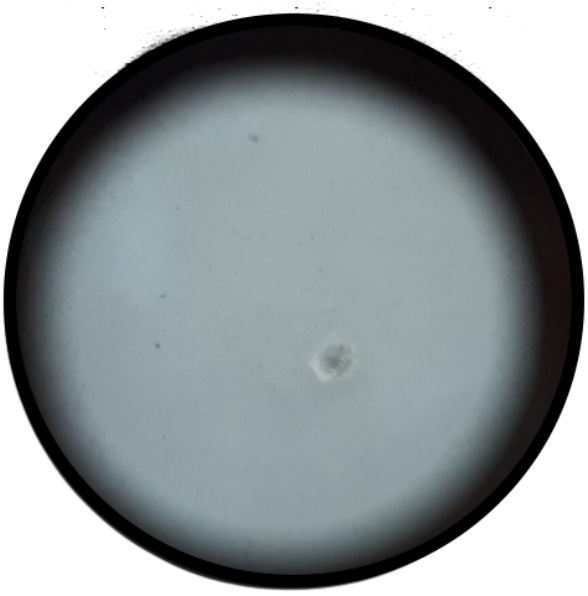
THE PROBLEM: LOW TEMPERATURES

What if the temperature of the ceramic body that leave the dryers is improper or too low?

This could cause **uneven drying of the final application of glaze or grit** before the tiles enter the kilns. This uneven drying process could lead to critical issues at the inter-phase (the touchpoint between two application layers) that result in different kinds of defects: **pinholes** are one of the most popular.

Since we cannot make a detailed list of the wide range of causes and effects, we can simply say, only as an example, that the **mix between different phases** (or layers) and the **abnormal presence of water** in the glaze during the firing process are the most important aspect to check since they are commonplace.

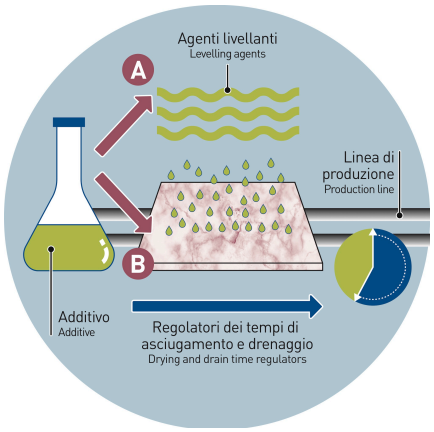




In very short words: **the pinholes formation starts from a lack of cohesion between the application layers because of the wrong temperature of the raw tile**.

MAIN CORRECTIVE ACTIONS

After this long introduction let's now introduce the actions that can prevent or even solve the problem.
The increase of the ceramic body's temperature could surely help the regulation and the adjustment of the drying process. However, the only use of high temperatures may lead to a fast and uncontrolled drying process, compromising the right cohesion between the applications.



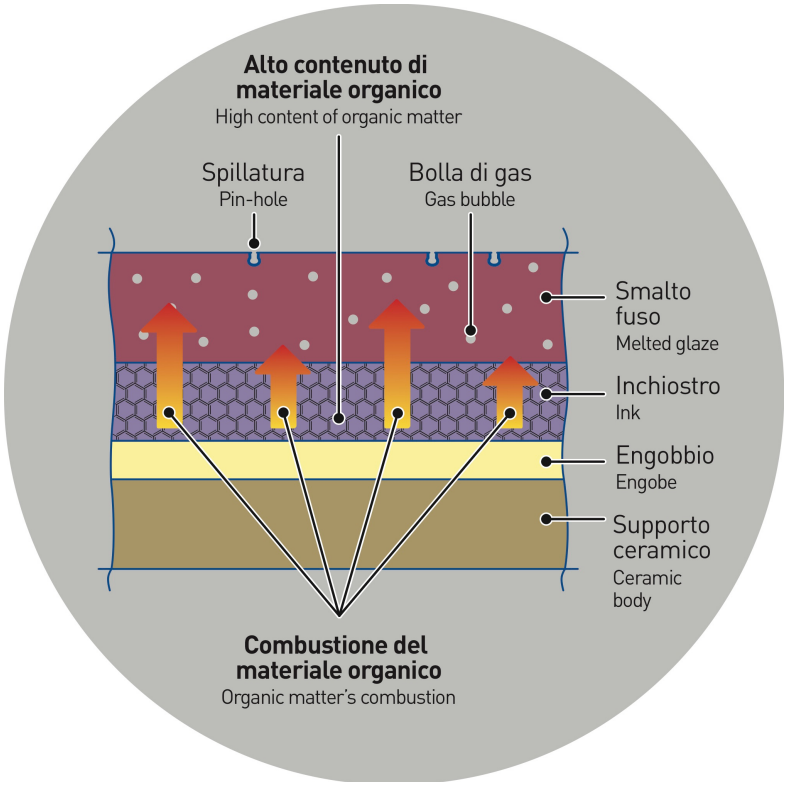
For this reason, the most significant and smart action is to add the glaze with a proper leveling agent or more generally with chemicals able to adjust and standardize the drying and drainage times, ensuring a good cohesion between the layers.

2. EXCESSIVE PRESENCE OF ORGANIC MATTER IN THE INKS

Pinholes can also appear when the graphic decoration of the tile includes patterns that require a huge amount of ink.

Why?
A significant quantity of ink involves the high presence of high boiling organic matter that does not evaporate inside the kiln during the first stage of the firing process. If the amount of glaze (or grit) discharged on the ink is significant as well, the problem comes out.

What happen?
It happens that some of the organic matter of the ink may not reach the burning stage before the melting process of the glaze (or grit). The problem is that the combustion of the ink's organic matter keeps going even after the melting process of the glaze and this means that some of the organic matter is no more able to leave the tile, forming **gas bubbles that remain trapped inside the glaze or inside the grit**.
The bubbles that rise on the glaze surface (that is now vitrified) explode, producing holes and pinholes that affect the ceramic.



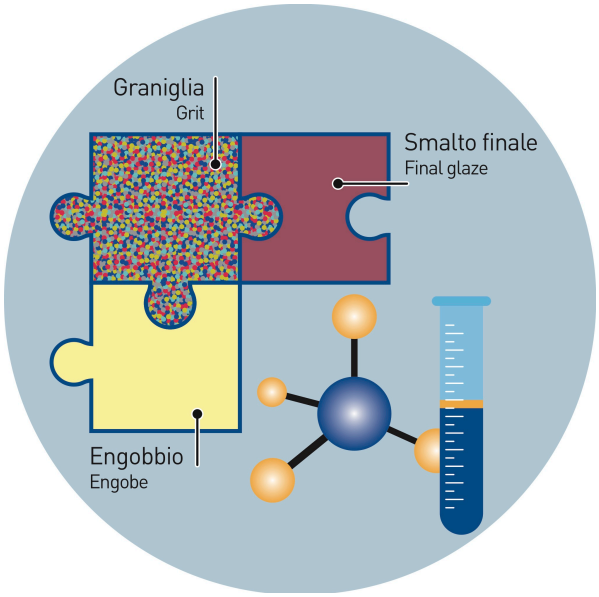
MAIN CORRECTIVE ACTION

Since it is **not** possible to increase the times of the firing cycle to provide the organic matter with longer time to properly evaporate, because of industrial productivity reasons, one of the most effective solutions is the use of inks marked by a better combustion of the solvent, that in turn is marked by a burning process able to remove most of the **flue gas** before the melting process of the glaze.

3. CHEMICAL INCOMPATIBILITY BETWEEN ENGOBE, GRIT AND GLAZE

Pinholes can be also promoted by an improper balance between the materials involved in the production process.

What does that mean?
We are talking about the relation between engobe, grit and glaze applied at the end of all processes as a protection covering. These three, are usually chosen to provide the glaze with the best conditions in terms of compatibility, uniformity as well as fusibility during the firing process.



The problem usually arises during the first production of a new product range when producers define the combination of materials to be used. If the latter show even a small chemical incompatibility many different issues may occur during application.

In all these cases, we should take two directions:
on the one hand, glaze producers should focus on the specific formulation of the glaze (or of the grit), because sometimes these two could not meet the production parameters of the ceramic producer such as - for example – the application technology or the kind of firing cycle.

On the other hand, the parameters should be also revised inside the labs by studying the rheology of the fluid, with which is possible to choose the right chemicals to promote the best possible application.
