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# CRYSTALLIZATION DAMAGE AT THE INTERFACES OF ARTWORKS

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## KEYWORDS

Crystallization damage, layered porous materials, ceramics, tiles, glaze defects

## ABSTRACT

Over the past decades, much has been learned about the effects of salt crystallization in porous structures. In order to uncover what happens in the more complex but also more realistic situation of layered porous materials, the JPI-CH CRYSTINART project was initiated in the fall of 2020. This project aims to develop an integrated approach for modelling and analysis of the decay mechanism due to salt crystallization in composite materials relevant to the art conservation practice.

The objects of interest in the study at hand are antique Dutch tin-glazed tiles. These tiles consist out of two parts: the clay body (~ 0.5 cm) and the tin glaze top layer (~300  $\mu\text{m}$ ) (Figure a & b). The body is made out of calcium-rich clay, so the thermal expansion coefficient suits the glaze during the firing of the tiles. The porosity of the body depends on the firing time and temperature [1].

Glaze defects are one of the common problems in the conservation of ceramics and tiles [2]. The defects are manifesting by (i) glaze peeling, (ii) crazing which is glaze cracking due to high surface tension and (iii) shivering which is a process that occurs when the separation between the glaze and the body induces the removal of a

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portion from the body [2]. Earlier research on Dutch tin-glazed tiles is mostly about the manufacturing process and the chemical composition of the tiles [1]. We aim to get a better understanding of the physical properties of tin-glazed tiles and their effect on salt weathering of these tiles.

Tin-glaze is a white and shiny glass. The glaze itself is in principle non-porous, but air and gas bubbles can be formed during the firing of the tile in the manufacturing process (black square in Figure 1a and b) [1]. Some tiles have a dense pattern of cracks visible in the glaze surface which is called craquelure (red square in Figure 1a-b). We performed our experiments on 2 x 2 cm samples cut out of antique tiles provided by the company *Regts antieke tegels* (Figure c). One tile, dating from the end of the 19<sup>th</sup> century, had no craquelure and has a measured porosity of around 25% (mass percentage). The other tile did have craquelure, was made in between the second half of the 18<sup>th</sup> century and the second half of the 19<sup>th</sup> century, and has a measured porosity of around 30%. Both glaze layers are partially wetting and hydrophilic as the contact angle of pure water on the glaze is  $\sim 30^\circ$ . From the SEM images and the X-ray scans, we observed that the craquelure is only present in the glaze layer and not in the clay body of the tile. Although the glaze itself should be non-porous, the craquelure can form a connection between the air and gas bubbles in the glaze layer and can create open porosity (Figure 1a and b). Still, the drying kinetics of the sample with craquelure and without craquelure are similar as the craquelure is small compared to the open sides of the tiles (Figure 1c).

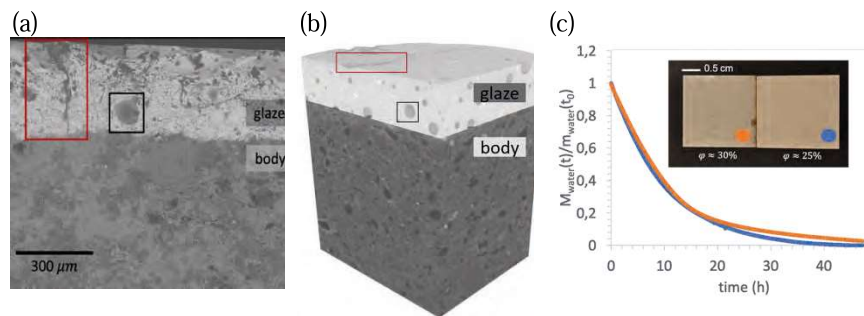


Figure 1: SEM image (a) and 3D X-ray CT reconstruction (b) of the glaze-body interface. An example of craquelure is marked in the red square and an example of an air bubble within the glaze in the black square. (c): Drying kinetics of 2 x 2 cm samples of a tile with craquelure (orange curve) and without craquelure (blue curve).

In the next step of this study, salt weathering cycles will be imposed on tile samples with and without craquelure to assess how salt damage is affected by the extra air inlet of the craquelure. In addition, we will investigate how the salt crystallization itself can cause cracks and craquelure.

## **REFERENCES**

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