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Iron rebars have been used for centuries in stone monuments. Their corrosion seriously endangers the structural integrity of the monument in the long term and thus needs to be appropriately assessed and understood. Corrosion layers are constituted of different iron oxides and oxi-hydroxides, along with a significant porosity which plays a significant role in the corrosion process by allowing transport of electrolytes from outside to the vicinity of the metal core [1]. Previous investigations by X-ray microtomography have shown that this porosity forms a complex and anisotropic network with pores ranging from the micro- to the nano-scale [2].
Here we show that time-resolved X-ray microtomography allows to visualize the flow of water within the corrosion layers, a first step towards the quantification of important transport properties such as permeability and diffusion coefficients. Samples of corroded iron rebars from the cathedral of Metz were cut and embedded into resin to present a cavity on the top of the corroded surface where water mixed with a contrast product was added. X-ray microtomography images of 870nm voxel size were acquired by propagation phase contrast on the PSICHE beamline, with a pink beam of 63keV. After imaging of the dry sample, the contrast solution was added and tomography images were acquired every few minutes, allowing after suitable image processing the 3D time-resolved visualization of water percolation in the corroded layers (Figure 1). We further characterized the process by means of several metrics (chord distribution functions, Betti numbers and diffusion coefficient computations) and could evidence a two-step percolation dynamics and the influence of sub-resolution nanoporosity.

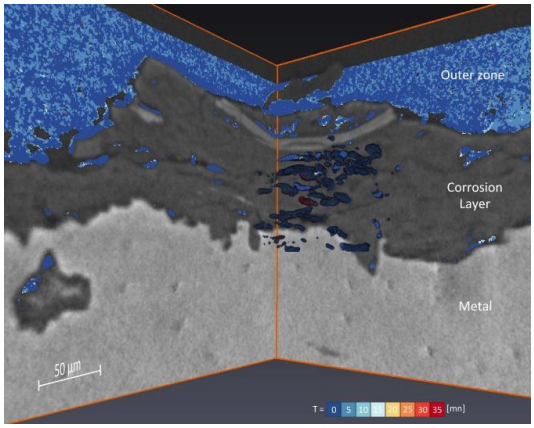

Fig. 1 Water percolation of the porosity over time (blue: immediate, red: 30-35 minutes) in the corrosion layer of an iron rebar from the cathedral of Metz. Red zones show pores not directly connected to the main porosity network, where water percolates only in a second stage.

References

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[2] Jacot-Guillarmod M., Rozenbaum O., L'Hostis V., Dillmann P., Neff D., and Gervais C., *Journal of Atomic Analytical Spectroscopy*, 30(3):580–587, 2015.