

Microstructure Analysis of Cement-Based Materials using micro X-Ray Fluorescence

Alain B. Giorla¹, Elena Tajuelo-Rodriguez¹, Stephanie Curlin¹, Ammar Abd-Elssamd², Yann Le Pape¹,
Thomas M. Rosseel¹

¹Oak Ridge National Laboratory, Oak Ridge, TN, USA

²University of Tennessee, Knoxville, TN, USA

Micro X-Ray Fluorescence is a powerful technique to characterize the elemental composition of materials at the microstructure level. In this work, micro-XRF images of cementitious materials (pure cement paste, rocks, and concrete) are obtained and characterized. The method provides the localization of the porosity, cement paste, and the different mineral phases throughout the specimen.

The quantification of the elemental maps is obtained from the intensity maps with an unbiased method using internal standards. Particles are then identified in the microstructure from the gradients of the elemental concentrations, which allows the user to sharpen the contrast in the image and facilitate phase identification. A shape identification algorithm is used to isolate the porosity in the image and therefore negate the shadow artifact that appears around air bubbles. The cement paste is then segmented using a threshold in the Calcium concentration. Finally, the different mineral phases in the aggregates are each identified from a user-defined list depending on their elemental composition.

The method has been tested on cement paste, rock and concrete specimens with various compositions. The limitations of the methods are discussed, including the difficulty of distinguishing minerals with similar composition, and to identify non-circular pores (such as cracks).