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How the characterization of cement-based materials by beamline techniques can boost sustainable development in Africa

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The African continent is the one with the highest rate of urbanisation and it is expected that the local demand of building materials, such as cement, will drastically increase to support demographic, urban and economic growth. Most African countries are net cement importers and this, combined with the need of cutting CO2 emissions associated with Portland cement production and transport, may stimulate the development of a local cement industry, which may lead the global transition towards sustainability. Indeed, raw materials for the production of alternative cements, such as kaolinitic clays, are abundant across Africa, and a sustainable exploitation of these resources can contribute to both reducing the African dependence on cement import and favouring the creation of new jobs.
The design of sustainable binders, alternative to Portland cement, necessitates a bottom-up, knowledge-based approach, by which the understanding of small-scale chemical processes represents a fundamental step towards the engineering of materials with tailored macroscopic properties.
This contribution illustrates how fundamental knowledge of the processes occurring at the solid-liquid interface in cement systems can be acquired by different beamline techniques, relying on both synchrotron light and neutron sources. Specifically, advanced methods based on XRD-microtomography, near-field ptychographic and holographic nano-tomography, and neutron dark field imaging were implemented to assess the details of microstructural evolution in cement-based materials, and how the kinetics of this process can be modified to control the material's engineering properties.

Primary author: Prof. VALENTINI, Luca (University of Padua)

Presenter: Prof. VALENTINI, Luca (University of Padua)

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