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Remote sensing to evaluate carbonation kinetics of concrete

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One of the biggest challenge of the coming years will indeed be the reduction of greenhouse gases (GHG) as CO_2, but also their trapping through several mechanisms. Cement production is one of the most significant emitter of CO_2 generated during limestone calcination. Nevertheless, one of the main pathology of concrete is its carbonation with an alteration of its mechanical properties. There are very few techniques to properly appreciate to what extent this reaction has modified the concrete, besides a coloration with phenolphtaleine or extremely invasive analytical techniques such as TGA-MS and gamma densimetry. They are respectively too qualitative and not field-adapted. Within the frame of both the reduction of GHG and the understanding of carbonation pathology, some preliminary investigations were undertaken with a Raman spectroscopy monitoring of a given cement paste in an atmosphere enriched with CO_2 in controlled condition. This research was performed through a collaboration of IFTTAR, Cerema, LMOPS and IJL in France. This approach was reinforced by a literature review indicating the benefits of such a spectroscopy, through the detection of chemical phases related to carbonation, a quantification of these phases if necessary. Raman spectrometry is fast enough now to allow a high frequency monitoring of the chemical process. Considering the large amount of collected data, chemometrics tools were employed to analyze Raman spectra to identify any existing structure groups in the spectra population, along with potential specificities within this process. Results indicated an early detection of the carbonation reaction by Raman spectroscopy, and a partition in the spectra population representative of microstructural evolutions while phenolphtaleine test was not able to fully discriminate where the carbonation took place.