CO_2 utilization for transformation of demolishing waste into cementitious materials

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Production of 1 t of cement is associated with ~0.8 t of CO_2 emissions of which the main part is related to the limestone calcination. When mixed with water, cement reacts to produce hydrates responsible for concrete hardening. After the service life, concrete structures are demolished to produce, among others, concre fines, i.e. the hydrated cement. Cement hydrates are able to react with the CO_2 present in the atmosphere and bind CO_2 back into calcite. The large amount of demolished concrete hence represents a significant CO_2 sink. However, the carbonation process of the concrete is slow and takes decades.

This work reports on the progress of work targeting closing the CO_2 loop in concrete industry by using the CO_2 emitted during the cement production from the limestone decomposition to produce reactive cement components by carbonating the concrete fines. To achieve this target, the carbonation process needs to be enhanced and accelerated from decades to minutes to maximize the CO_2 capture in the industial process.

In order to optimize the carbonation process, direct wet carbonation of the concrete fines was investigated at mild temperatures. Multitechnique approach was applied to characterize the carbonation process including the analysis of solids and of solution during the carbonation. In parallel to the traditionl direct methods (XRD, DTG, SEM, FTIR-AR, ISP-OES/MS), geochemical modelling was applied.

The results revealed that the accelerated carbonation involves complex multistage processes of re-hydration and carbonation reactions of the original components and newly created meta-stable phases. The carbonated concrete fines are characterized by highly pozzolanic properties, which make them suitable for further re-use in cements as a reactive component.