Final Report

Project acronym: *CCSRender*

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M-ERA.NET Call 20*16*

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2. Publishable project summary

Focus on methodology, results and conclusions (max. 1 page).
Please note: The publishable summary will be used for dissemination by M-ERA.NET and the EC.

Anthropogenic activities over the past century have caused a dramatic increase of carbon dioxide (CO_2) concentration in the atmosphere. A potential solution to this crucial problem is the storage of CO_2 via mineral carbonation, which comprises one of the most promising carbon capture and storage (CCS) technologies.

The aim of the CCSRender project was the development of novel, environmentally-friendly lime-based renders with the ability to sequester CO_2 directly from the atmosphere via *in situ* mineral carbonation. This was achieved through the addition of suitable mafic/ultramafic rocks (including quarry waste materials) in nanoscale to the aforementioned composites, following the application of the ball milling process. The latter has proved to be very efficient in increasing the CO_2 uptake of mafic and ultramafic rocks.

The first stages of the project included fieldtrips in the Troodos ophiolite complex, during which mafic/ultramafic rocks and quarry waste materials were sampled. Based on the mineralogical composition of these rock samples, the most promising ones were subjected to ball milling in order to create nanoscale rock powders with enhanced CO_2 sequestration capacity. Mafic quarry wastes from Hungary were also used for the development of ultrafine powders. In order to determine the optimum milling parameters for each individual rock sample, a significant number of ball milling experiments were performed in the framework of the project. The starting rock materials and the ball-milled samples were throroughly characterized using a variety of experimental techniques. The research team focused on the development of sufficient quantities of the most promising nano-sized powders in order to be used as additives during the preparation of render mix designs.

Several lime-based render mixtures were designed and prepared in the lab through the addition of the new nanomaterials, at different quantities (weight by weight as a replacement to lime). The hardened end-products were characterized through a variety of laboratory tests. The results revealed that the nano-modified renders showed a significantly denser microstructure compared to the reference composites, due to the nano-filler effect, in combination with the enhancement of the carbonation reactions. This indicated that the use of the aforementioned nano-additives in renders can (i) accelerate the carbonation reactions, thus enhancing the early-age physico-mechanical properties of the end-products, and (ii) contribute to the reduction of atmospheric CO_2 concentrations.

During the second half of the project, emphasis was also placed on the preparation of additional mix designs using different rocks/waste materials. The goal was to investigate the CO_2-storage capacity of the new composites in relation to the type and percentage of nano-additives, the carbonation mechanism of the most promising mix designs, as well as the changes induced to the microstructure of the latter during carbonation. The experimental results clearly showed the positive effect of specific nano-sized rocks/waste materials on the carbonation mechanism and physico-mechanical properties of air lime renders. The new nano-modified composites compared favorably with composites containing well-known commercial nano-additives (i.e., nano-silica). Pilot applications performed before the end of the project further demonstrated the better performance of the nano-modified mixtures, compared to the unmodified ones, under real exposure conditions.