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Grain and crystalline domain properties of a potential CO_2 storage unit

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FeCO3 can mitigate the anthropogenic CO2 emissions, by being a vital component in future carbon capture and storage (CCS) technologies. Inspired by the natural carbon storage mechanism of divalent metal carbonates, where FeCO3 plays an important role as a potential storage unit, CO2 is injected into a reactive divalent metal-containing rock, in which mineral carbonation occurs, forming FeCO3. This concept has been successfully implemented at carbon storage facilities on Iceland. To optimize the adsorption rate, the surface area of the reactive bed is an important parameter. However, the physicochemical properties of FeCO3 are not well understood, and in the current study, there has been found a strong correlation between the temperature, duration and pressure associated with the synthesis and the grain size of the synthesized product. Therefore, the physicochemical properties of FeCO3 must be investigated and mapped to tailor this process towards optimization of stored CO2.

By specifically investigating the size of a FeCO3 product by a patented synthesis, it was found that a linear correlation between the grain size and the scattering coherence length could be proposed.

All synthesis was performed in an anoxic environment by mixing Fe-ions and CO3-ions in a ¼ molar ratio and transferring the solution to a titanium piston autoclave, which could be pressurized, and heated in an oven for a chosen duration. To map the synthesis parameter space temperature, pressure, and synthesis duration were varied.

The analysis was performed with scanning electron microscopy (SEM) imaging, where more than 400 particles were counted for each sample to create a reliable dataset. Furthermore, x-ray diffraction (XRD) was performed from which the scattering coherence length was obtained from a custom-written MatLab script.

Our findings will lead to a better understanding of the interplay between grain and crystallite domain in the formation of FeCO3, thereby expanding the current knowledge of CO2 sorbents in general.