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Thermal properties of a CO2 sorbent and its possible degradation pathways

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Since FeCO3 poses as a potential storage unit for CO2, it is important as a component in future carbon capture and storage (CCS) technologies. Through mineral carbonation, CO2 can be stored in divalent metal carbonates, as CO2 reacts readily with the rock as it is injected underground. To optimize the adsorption rate, the thermal properties of FeCO3 (e.g. thermal degradation temperature) must be understood, as the reaction can occur under high temperatures. However, the thermal properties of FeCO3 are not well understood, and in the current study, it was found that the thermal degradation of FeCO3 was strongly dependent on the conditions at which it was synthesized. Therefore, the thermal properties of FeCO3 must be investigated in order to understand to formation of FeCO3.

All synthesis was performed in a glovebox box with an oxygen level of 10 ppm by mixing in a ratio of 1:4 Fe-ions and CO3-ions and transferring the solution to a 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 Thermogravimetric analysis (TGA), with a slow heating rate to ensure that the degradation had completely occurred. Furthermore, x-ray diffraction (XRD) was performed on products before and after heating, which could identify the phases, which occurred due to the degradation. It was found that the product of degradation was different if the synthesis was performed for 6 hours compared to 96 hours.

These results will enhance the current understanding of FeCO3 formation, thereby expanding the current knowledge of mineralization and underground mineral properties, especially linked to decomposition of minerals for underground geothermal applications.