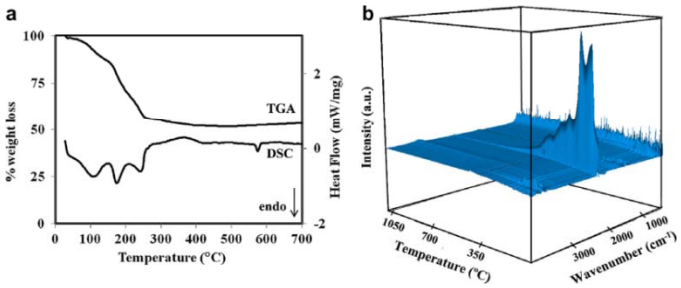
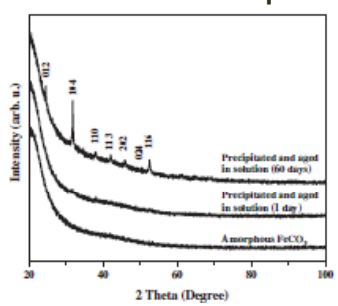
Amorphous iron (II) carbonate: Crystallization energetics and comparison to other carbonate minerals related to CO_2 sequestration

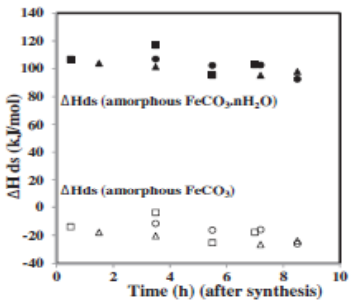
(a) TGA-DSC and (b) FTIR of TG evolved gas of AFC



XRDs of AFC samples



Calorimetric data of AFC



Crystallization enthalpies (ΔH_{crys}) of amorphous carbonates

Amorphous phase	H_2O, n (mol)	M^{2+}radius (pm)	ΔH_{crys} (kJ/mol)
$FeCO_3.nH_2O$	1.75	77	-37.8 ± 9.8
$MgCO_3.nH_2O$	1.28	80	-35.8 ± 1.2
$CaCO_3.nH_2O$	1.13 - 1.58	114	-17 ±1 & -24 ±1

Mineralization of iron (II) carbonate is complex and involves abiotic and biotic mediations for the establishment and maintenance of reductive microenvironments. Abiotic formation of iron (II) carbonates by the reaction of iron oxide, ferrihydrite and oxyhydroxides with CO_2 waste stream containing H_2S or SO_2–CO_2 may sequester significant amount of carbon dioxide as carbonates. Kinetic and carbon isotope partitioning studies of inorganic precipitation of siderite suggest that it forms through a series of metastable precursors.

In this work, we were able to synthesize, isolate and study the thermodynamic properties of the amorphous precursor phase formed during the precipitation of siderite using high-temperature oxide-melt drop-solution calorimetry. Our calorimetric results indicate that the amorphous $FeCO_3$ (AFC) precursor provides a low energy pathway for crystallization of siderite.

AFC is energetically similar to amorphous $MgCO_3$ (AMC) and more metastable than amorphous $CaCO_3$ (ACC). AMC is more persistent than either ACC or AFC, despite being more metastable. This may relate to strength of hydration. Enthalpy of crystallization (ΔH_{crys}) is ionic size controlled.

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