Supporting Information for

Ultrafast, Scale-Up Synthesis of Pure and Stable Amorphous Carbonate Mineral Nanoparticles

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Table S1. A comparison between previously reported ACC synthetic procedures and current work.

Typical preparation of ACC nanoparticles with stabilizers/additives

Stabilizers/additives	Ref.
Poly(acrylic acid) (PAA)	1, 2
Poly(ethylene oxide)-*b*-poly(acrylic acid) (PEO-*b*-PAA)	3
Mg^{2+}	4, 5
Silica	6
Phytic acid	7
Adenosine 5'-triphosphate disodium salt (ATP)	8
Polymerized dopamine	9

Typical preparation of pure ACC nanoparticles

Method	Time	Yield	Drawbacks	Ref.
Direct mixing the aqueous solutions of Na_2CO_3 (with a small amount of NaOH) and $CaCl_2$ at 4 ^oC	< 10 s	-	Poorly controlled, ACC easily crystallizes	10, 11
Vortex fluidic mixing in water/ethylene glycol mixture	30 min	-	Special device needed	12
Hydrolysis of dimethyl carbonate in the aqueous solution of calcium salt	2.5 min	72% or 41%	Low concentration of the precursor solution (1 mM $CaCl_2$)	13
Titration	30-40 min	Low	Special device needed, low yield (2-5 mg from ~200 mL solution)	14
Gas diffusion into the ethanolic solution of calcium salts	24 h or 3 days	-	Time-consuming	15,16
Freeze-drying from a saturated $CaCO_3$ solution	> 24 h	Low	Time-consuming, low yield	17
Current work	< 1 min	> 78.5%	-	-

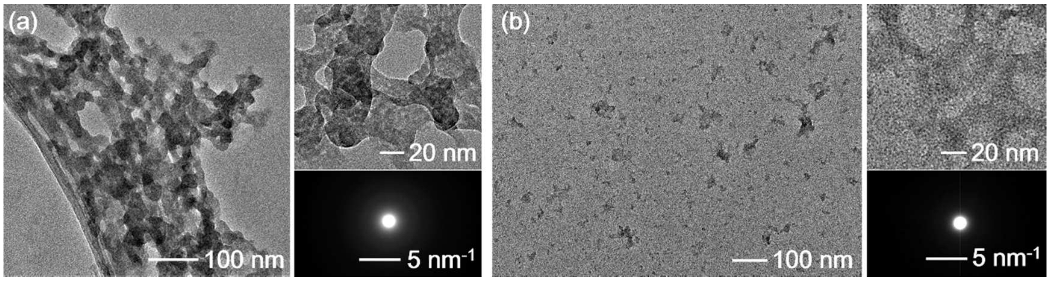

Figure S1. TEM images and corresponding SAED of (a) $Ca_xMg_y(CO_3)_z$ and (b) $Ca_xSr_y(CO_3)_z$ nanoparticles.

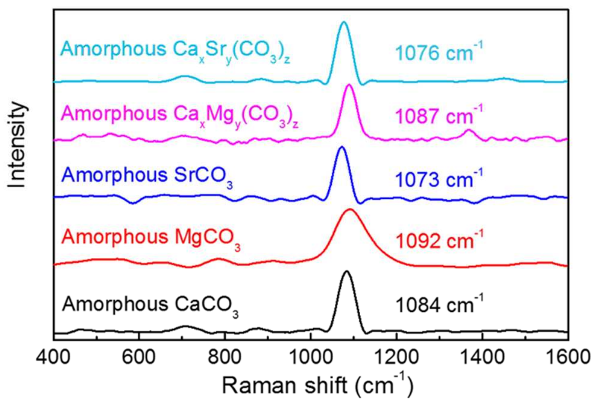

Figure S2. Raman spectra of amorphous $CaCO_3$, $MgCO_3$, $SrCO_3$, $Ca_xMg_y(CO_3)_z$ and $Ca_xSr_y(CO_3)_z$.

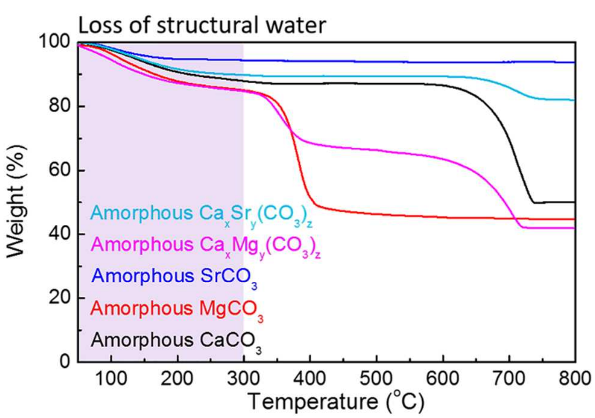

Figure S3. TGA results of amorphous $CaCO_3$, $MgCO_3$, $SrCO_3$, $Ca_xMg_y(CO_3)_z$ and $Ca_xSr_y(CO_3)_z$ prepared with 5 min of high-pressure CO_2 injection. Apparently, extending reaction time does not induce obvious compositional changes of the amorphous minerals.

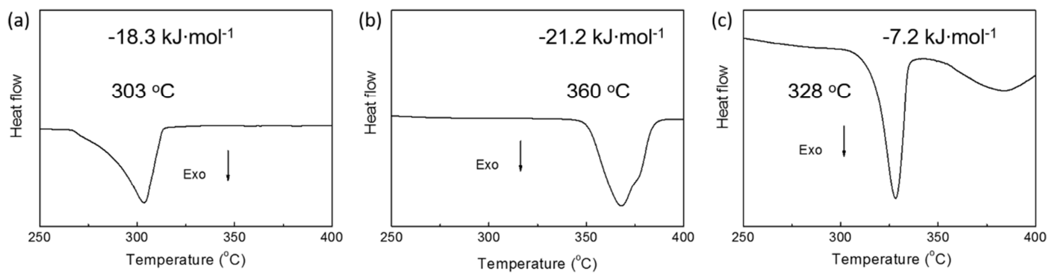

Figure S4. DSC traces for the crystallization of amorphous $CaCO_3$, $MgCO_3$ and $SrCO_3$ (10 $K\cdot min^{-1}$).

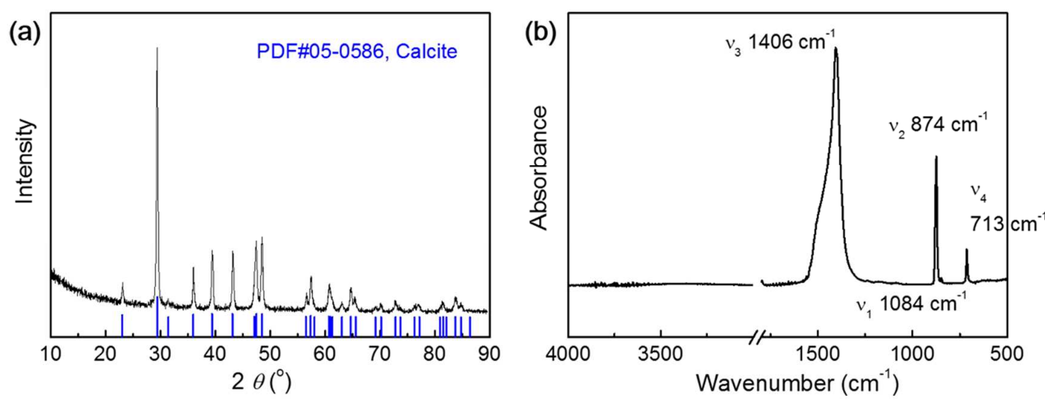

Figure S5. (a) XRD profile and (b) FTIR spectrum of the as-prepared ACC after being heated at 400 ^{o}C in air for 3 h.

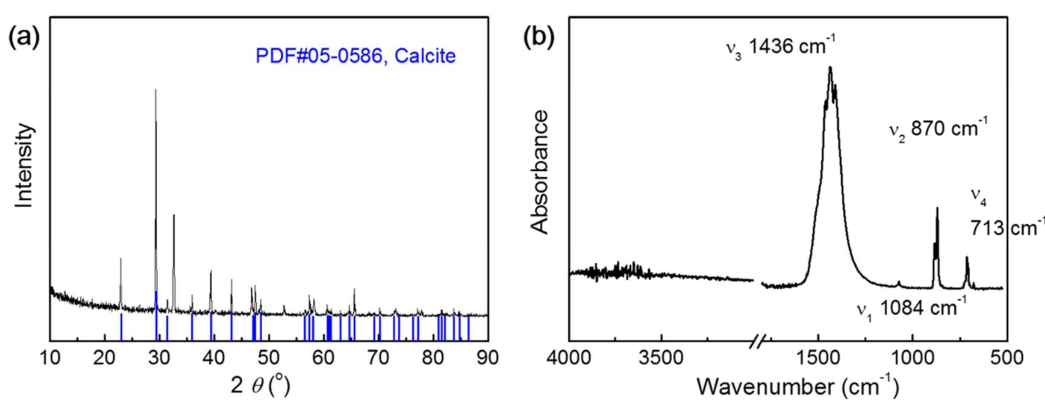

Figure S6. (a) XRD profile and (b) FTIR spectrum of the as-prepared ACC re-precipitated in deionized water.

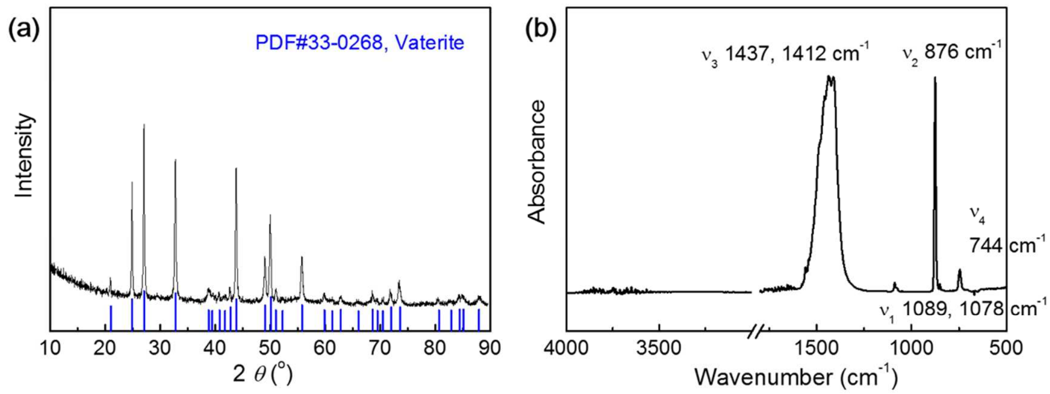

Figure S7. (a) XRD profile and (b) FTIR spectrum of the as-prepared ACC re-precipitated in a mixed solvent of ethanol and water, where the water content is 15 wt%.

$CaCO_3 \cdot H_2O$ (ACC) + Co^{2+} + OH^- $\rightarrow$ $CoCO_3\downarrow$ + $Co(OH)_2\downarrow$

$CaCO_3 \cdot H_2O$ (ACC) + Cu^{2+} + OH^- $\rightarrow$ $Cu_2(OH)_2CO_3\downarrow$ + $Cu(OH)_2\downarrow$

$CaCO_3 \cdot H_2O$ (ACC) + Fe^{3+} + OH^- $\rightarrow$ $Fe(OH)_3\downarrow$ + $Fe_2O_3\downarrow$

Figure S8. Probable reaction schemes in the water treatment of heavy metal ions (Co^{2+}, Cu^{2+}, Fe^{3+}) by ACC.

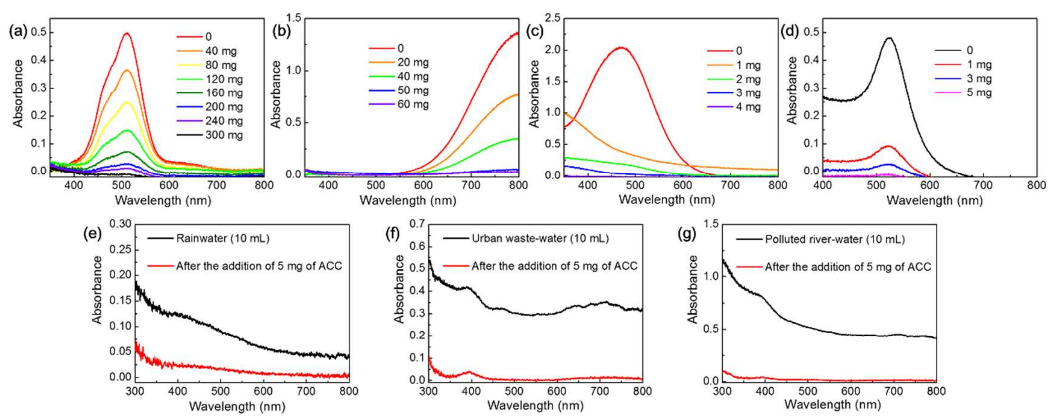

Figure S9. UV-vis spectra of (a) $Co(NO_3)_2$ (5 mL, 100 mM), (b) $CuCl_2$ (5 mL, 100 mM), (c) $Fe(SCN)_3$ (5 mL, 1 mM), and (d) Au NPs (2 mL ,200 $\mu g \cdot mL^{-1}$) aqueous solutions upon the addition of different amounts of ACCs. (e-g) UV-vis spectra of rainwater, urban-waste water and polluted river-water (10 mL) before and after the addition of 5 mg of ACC.

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