Electronic Supplementary Material (ESI) for Environmental Science: Nano.

Supporting Information

Removal and recovery of Pb from wastewater through a reversible phase transformation process between nano-flowerlike $Mg(OH)_2$ and soluble $Mg(HCO_3)_2$

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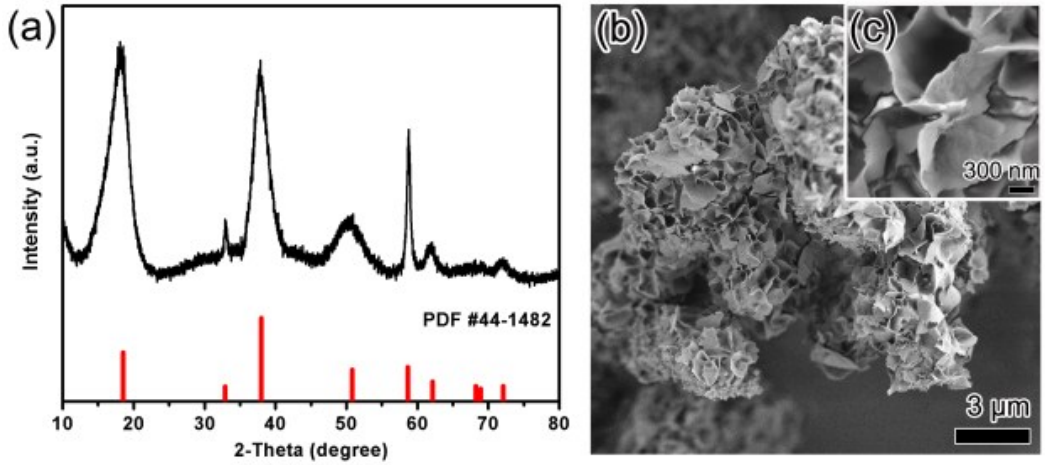

Figure S1. (a) XRD pattern and (b, c) SEM image of the as-prepared nano-$Mg(OH)_2$.

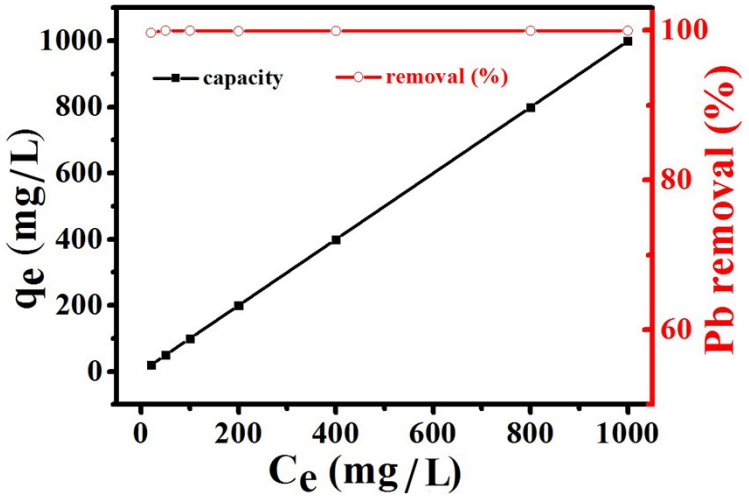

Figure S2. Effect of the initial concentration on adsorbed Pb^{2+} by nano-flowerlike $Mg(OH)_2$ (adsorbent dosage = 1 g/L, time = 12 h).

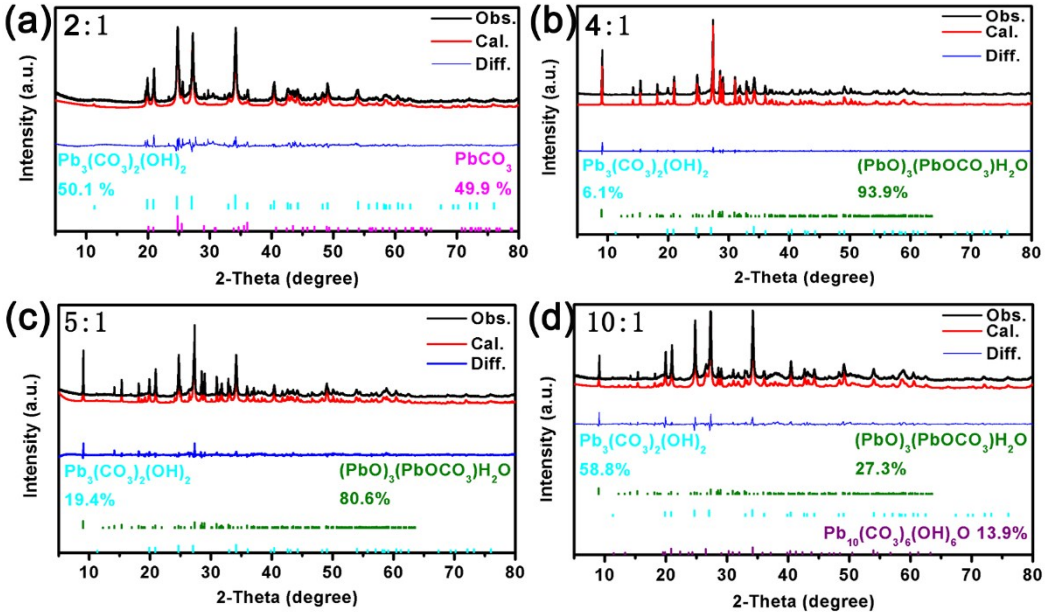

Figure S3. Graphical plots of Rietveld refinement of the Pb-loaded nano-$Mg(OH)_2$ solid waste at different initial mole ratios of Mg: Pb.

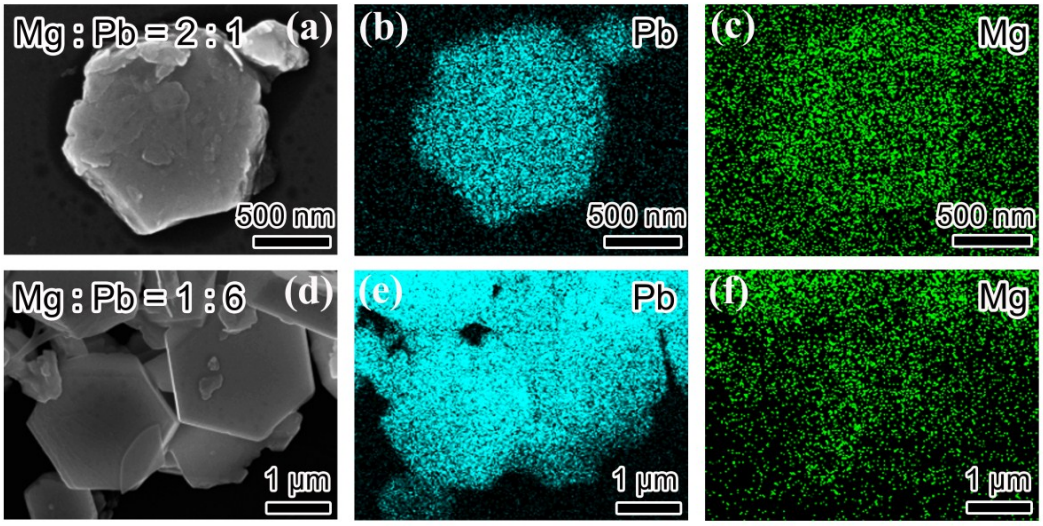

Figure S4. EDS-mapping images of element distribution of Pb-bearing nano-$Mg(OH)_2$ solid waste when the initial ratio of Mg: Pb is 2:1 (a, b and c) and 1:6 (d, e and f).

Table S1. The concentration Changes of pH, OH- and CO_3^{2-} in the solution during Pb^{2+} removal by $Mg(OH)_2$ under different initial molar ratios of Mg: Pb.

The initial mole ratio of Mg: Pb	The initial pH	The final pH	The initial C_{OH^-} (mmol/L)	The final C_{OH^-} (mmol/L)	The initial C_{CO32-} (mmol/L)	The final C_{CO32-} (mmol/L)	The C_{Pb2+} after reaction (mmol/L)
40:1	8.69	10.04	4.9×10^{-3}	0.109	0.136	0.571	1.17×10^{-4}
20:1	8.16	10.01	1.45×10^{-3}	0.102	0.061	0.460	1.06×10^{-3}
10:1	7.58	9.84	3.8×10^{-4}	0.069	0.048	0.118	1.43×10^{-3}
5:1	7.32	9.81	2.0×10^{-4}	0.064	0.046	0.063	1.51×10^{-3}
4:1	7.04	9.71	1.10×10^{-4}	0.051	0.040	0.053	2.17×10^{-3}
2:1	6.25	9.59	1.78×10^{-5}	0.039	/	0.03	0.93
1:1	6.15	7.41	1.41×10^{-5}	2.57×10^{-4}	/	0.02	2.54
1:3	6.11	6.71	1.29×10^{-5}	5.12×10^{-5}	/	0.019	3.67
1:6	6.01	6.33	1.02×10^{-5}	2.13×10^{-5}	/	0.018	4.28

Table S2. Concentrations of Pb^{2+} and Mg^{2+} in the solution before and after CO_2 treatment at the initial ratio of Mg: Pb is 2:1.

CO_2 treatment	**Concentrations (mg/L)**	
	Mg^{2+}	**Pb^{2+}**
before	0.25	0.0121
after	690.2	0.0205

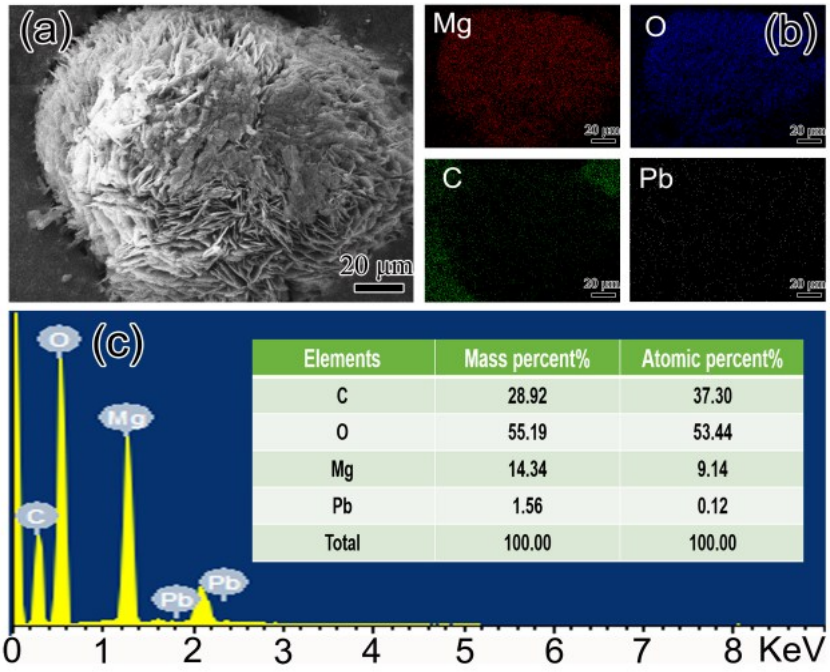

Figure S5. (a) SEM-mapping images, (b) Elemental mappings of Mg, O, C, Pb, and (c) EDS spectrum of the product from the solution after carbonation. The inserts in (c) is the percentage of Mg, O, C and Pb.

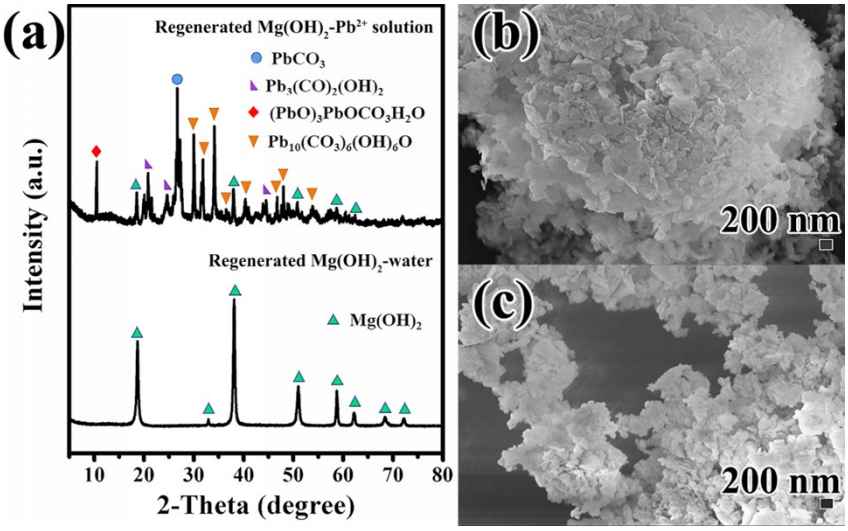

Figure S6. (a) XRD pattern of the regenerated $Mg(OH)_2$ products obtained by hydration in pure water and Pb^{2+} solution; (b) SEM image of the regenerated $Mg(OH)_2$ products obtained by hydration in pure water; (c) SEM image of the regenerated $Mg(OH)_2$ products obtained by hydration in Pb^{2+} solution.

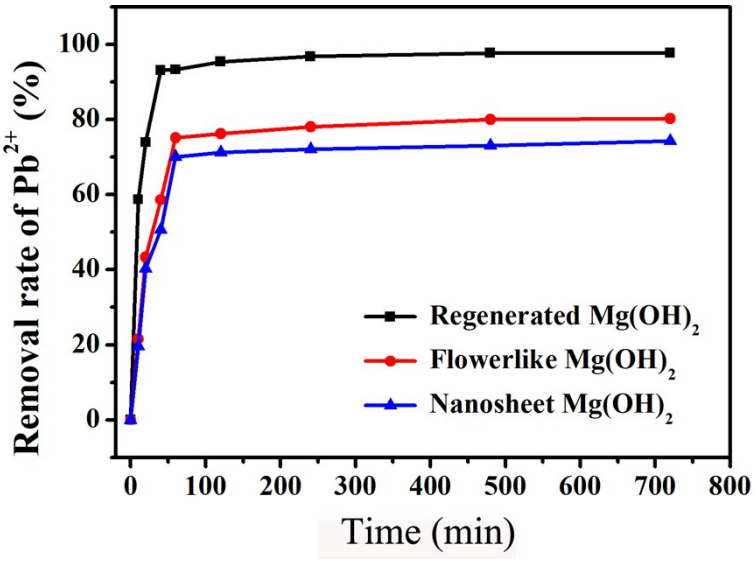

Figure S7. The removal rate of Pb^{2+} by regenerated $Mg(OH)_2$, flower-like $Mg(OH)_2$ and nanosheet $Mg(OH)_2$ under the same conditions (initial concentration of Pb^{2+} = 1000 mg/L, adsorbent dosage = 0.56 g/L, time = 12 h).

Table S3. Recovery rates in each step of the Pb removal and $Mg(OH)_2$ recovery process proposed at the initial ratio of Mg: Pb is 2:1.

	Step I	Step II	Step III
Mg	Mg residual rate = 25.41 %	residual Mg pressure dissolution rate = 97.5 %	dissolution Mg recovery rate = 91.56 %
Pb	Pb^{2+} removal rate = 80.08 %	Pb recovery rate = 100 %	

Table S4. Reaction products of $Mg(OH)_2$ with CO_2 under different pressures and different water contents.

$Mg(OH)_2$ (g)	**H_2O (mL)**	**Pressure of CO_2 (Mpa)**	**Reaction time (h)**	**Reaction temperature**	**Product**	**Reference**
1	1.38	0.5	8	RT	$MgCO_3 \cdot H_2O$	1
1	34.3	1.5	2	RT	$MgCO_3 \cdot H_2O$	2
1	1	0.5	12	RT	$MgCO_3 \cdot H_2O$	3
1	34.4	5	48	RT	$MgCO_3$	4
1	200	0.5	12	RT	$Mg(HCO_3)_2$	In this paper

RT: 25 ^oC

References:

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2 K. J. Fricker and A. A. Park, Investigation of the different carbonate phases and their formation kinetics during Mg $(OH)_2$ slurry carbonation, *Ind. Eng. Chem. Res.*, 2014**, 53**, 18170-18179.

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