

Supplementary information

**Preparation of cobalt-containing spinel oxides as novel adsorbents
for efficient phosphate removal**

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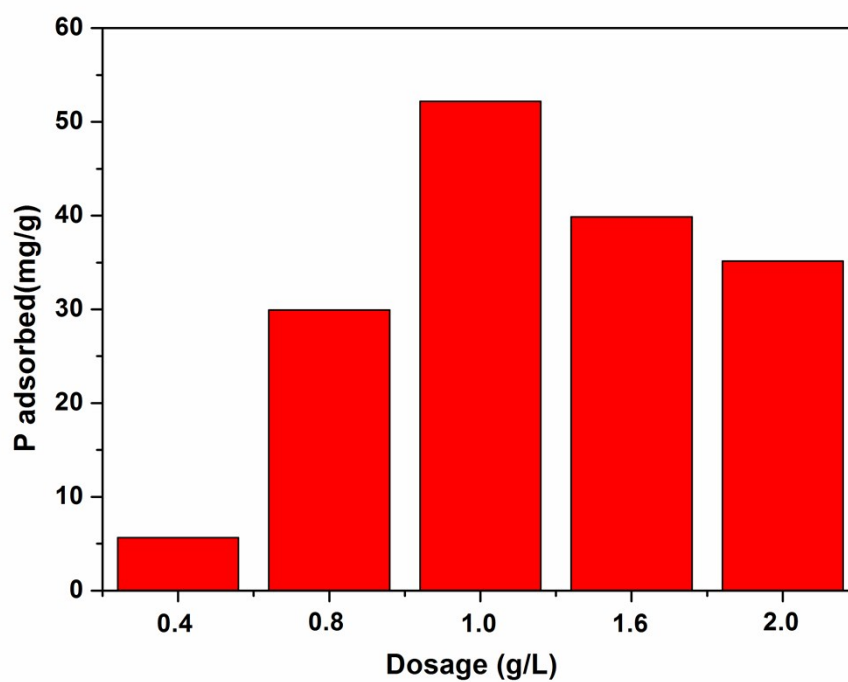


Fig. S1. Effect of dosage on adsorption of phosphate on MgCo_2O_4 . (Initial phosphate concentration: 100 mg L^{-1} ; Temperature: 303K ; $\text{pH} = 5.0 \pm 0.2$; $T = 24 \text{ h.}$)

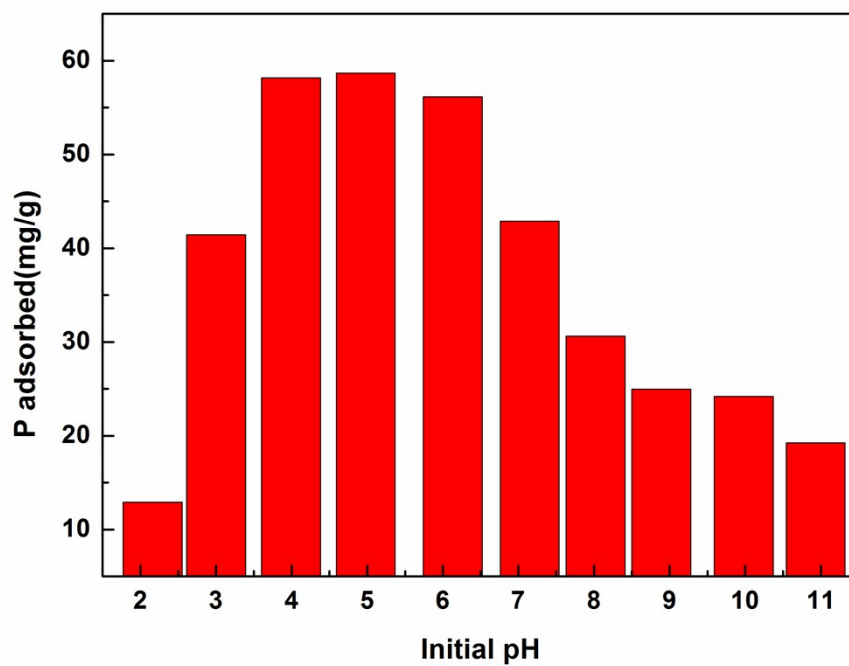


Fig. S2. Effect of pH on adsorption of phosphate on MgCo_2O_4 . (Initial phosphate concentration: 100 mg L^{-1} ; Adsorption dose: 1 g L^{-1} ; Temperature: 303K ; $T=24 \text{ h.}$)

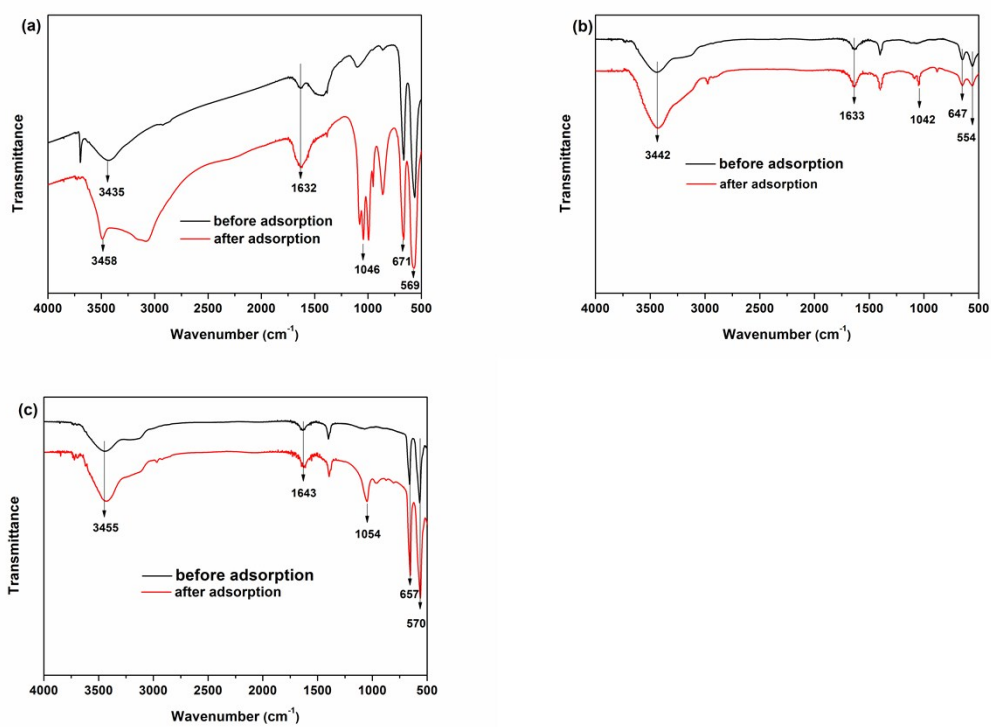


Fig. S3. IR spectra of MgCO_2O_4 (a), MnCO_2O_4 (b), CuCO_2O_4 (c). (Initial phosphate concentration: 100 mg L^{-1} ; Adsorption dose: 1 g L^{-1} ; Temperature: 303K ; $\text{pH}=5.0 \pm 0.2$; $T=24 \text{ h.}$)

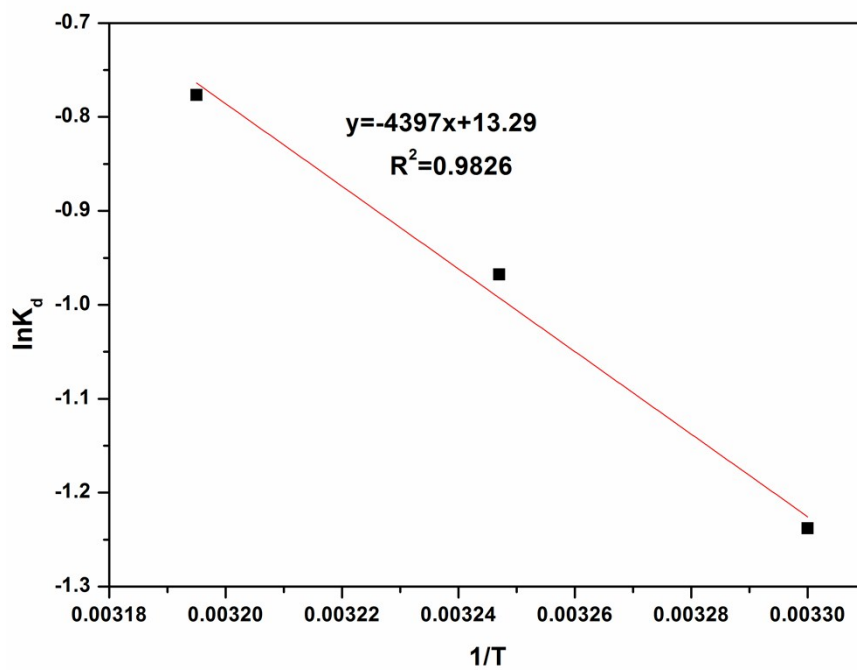


Fig. S4. Plot of $\ln K_d$ vs. $1/T$ for the adsorption of phosphate on MgCo_2O_4 . (Adsorption dose: 1 g L^{-1} ; $\text{pH} = 5.0 \pm 0.2$; $T = 24 \text{ h}$.)

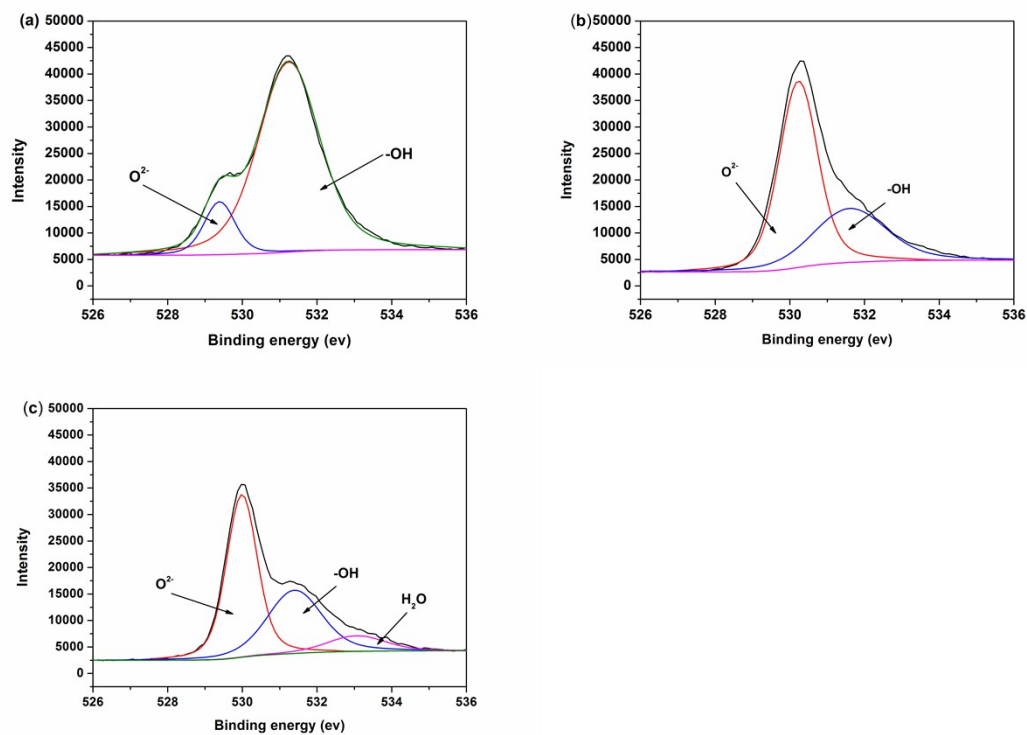


Fig. S5. O(1s) spectra of (a) $MgCo_2O_4$, (b) $MnCo_2O_4$, and (c) $CuCo_2O_4$. (Initial phosphate concentration: 100 mg L^{-1} ; Adsorption dose: 1 g L^{-1} ; Temperature: 303K ; $\text{pH}=5.0 \pm 0.2$; $T=24\text{ h.}$)

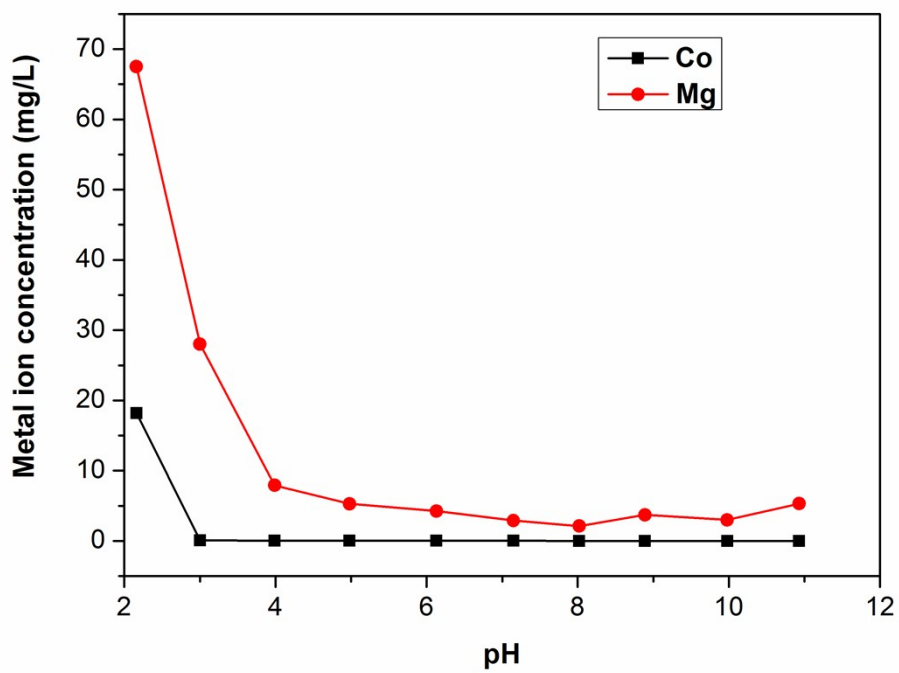


Fig. S6. Metal ion concentrations leached out from MgCo_2O_4 under different pH solutions. (Initial phosphate concentration: 100 mg L^{-1} ; Adsorption dose: 1 g L^{-1} ; Temperature: 303K ; $T=24 \text{ h.}$)

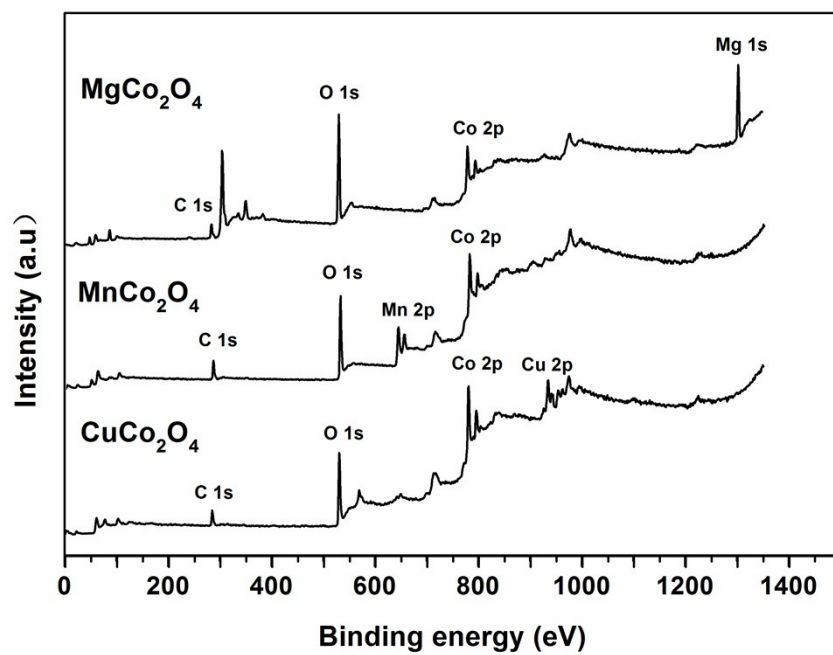


Fig. S7. Wide scan XPS spectra of (a) MgCo₂O₄, (b) MnCo₂O₄ and (c) CuCo₂O₄.

(Initial phosphate concentration: 100 mg L⁻¹; Adsorption dose: 1 g L⁻¹; Temperature:

303K; pH=5.0 ± 0.2; T=24 h.)

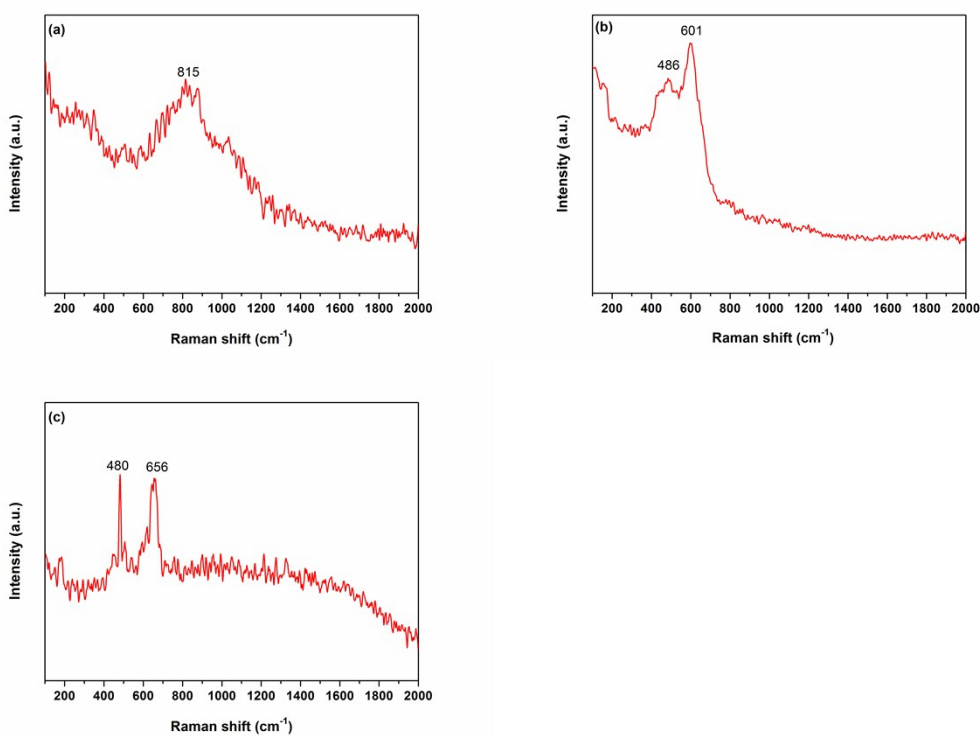


Fig. S8. Raman spectra of MgCo₂O₄ (a), MnCo₂O₄ (b) and CuCo₂O₄ (c). (Initial phosphate concentration: 100 mg L⁻¹; Adsorption dose: 1 g L⁻¹; Temperature: 303K; pH=5.0 ± 0.2; T=24 h.)

Table S1. O(1s) peak parameters for different materials. (Initial phosphate concentration: 100 mg L⁻¹; Adsorption dose: 1 g L⁻¹; Temperature: 303K; pH=5.0±0.2; T=24 h.)

Adsorbent	Peak ^a	Binding energy	Percent ^b
MgCo ₂ O ₄	O ²⁻	529.4	12.32
	OH ⁻	531.2	87.68
MnCo ₂ O ₄	O ²⁻	530.2	35.23
	OH ⁻	531.6	64.77
CuCo ₂ O ₄	O ²⁻	530.0	53.61
	OH ⁻	531.4	36.72
	H ₂ O	533.1	9.67

^a Surface species: O²⁻, oxygen bonded to metal; OH⁻, hydroxyl bonded to metal; H₂O, sorbed water.

^b The percentage represents the contribution of each peak to the total number of counts under the O(1s) peak.