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Zn-doped Li/Al layered double hydroxides for selective lithium extraction from brines: the impact of synthesis conditions on the performance

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The demand for lithium is rising substantially due to the technological progress of modern electric vehicles and field of energy storage. Therefore, more efficient Li extraction methods from brines must be developed, to meet the needs of rapidly growing industry. Direct lithium extraction technology (DLE) employing Li-selective adsorbents demonstrates a favorable balance of key features such as high selectivity for lithium and broad applicability across diverse brine resources [1].

This study investigated the impact of different approaches to synthesis of Zn-doped Li/Al layered double hydroxides (LDHs) on their Li extraction performance. The syntheses were carried out by coprecipitation method at room temperature using Li, Al(III), and Zn(II) chlorides or nitrates (Li/Al ratio: 1:2). Partial substitution of structural Al(III) by Zn(II) was targeted, with loadings of 5 and 10% relative to Al(III). In the first approach, metal-containing solution was added dropwise (5 mL/min) to a beaker with distilled water. The pH was maintained at 5-6 with 3 M NaOH. In the second method, the metal-containing solution was added dropwise to a beaker containing 8 M NaOH until the pH of the suspension was lowered to ~5. The final precipitates were aged for 30 min or 24 h, then recovered by centrifugation, water washed and dried at 60°C.

The XRD analysis confirmed the formation of LDHs in all cases with basal spacing reflection equal to ~9.0 Å for the LDH-NO_3 and ~7.7 Å for the LDH-Cl. Desorption-adsorption experiments indicated differences in the materials' performance depending on the synthesis protocol used. The materials formed in 8 M NaOH exhibited higher Li adsorption 3.30±0.25 mg/g and desorption 1.10±0.35 mg/g evaluated in 3 cycles. In contrast, the materials prepared by standard coprecipitation were characterized by lower Li adsorption 1.56±0.46 mg/g and desorption 1.05±0.28 mg/g. The presentation will also discuss the effect of Zn(II) doping on the materials' stability in brine environment.

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[1] H. Yu et al. (2022) Desalination, 539, 115951.