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Supporting information

Facile and sustainable recovery of spent $LiFePO_4$ battery cathode materials in a $Ca(ClO)_2$ system

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6 pages, 3 tables, 3 figures, 1 test

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Contents

Table S1

Table S1. Main components of SLFPB-Ms (wt.%).

Elements	Fe	p	Li	Al	Cu	F	C
Content	28.63	19.55	3.91	0.09	0.08	0.37	15.01

Notes: The content of F was determined by a fluoride ion selective electrode (ISE, PXSJ-216 F, INESA Scientific Instrument), and content of C in the sample was examined by a carbon-sulfur analyzer (CS-2800 G, NCS Testing Technology Co., Ltd.).

Figure S1

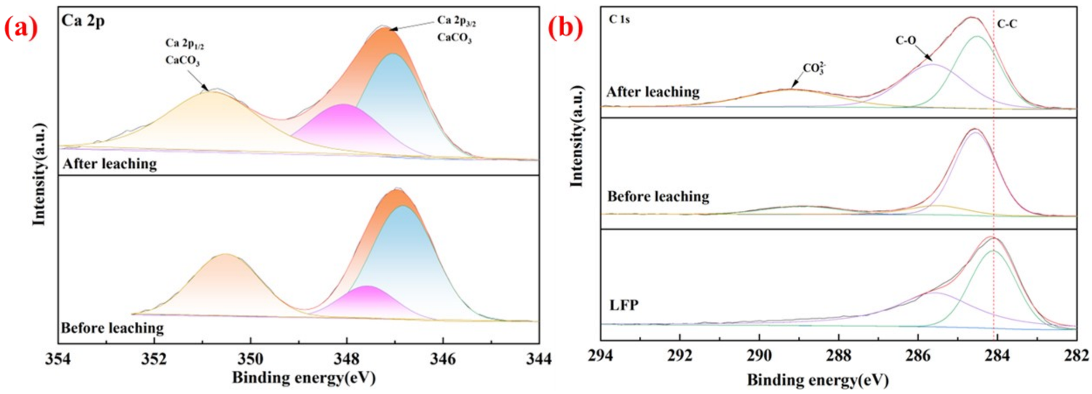

Figure S1. XPS spectra of (a) Ca 2p, and (b) C 1s for activated materials and leached residue (mass ratio of $Ca(ClO)_2/LiFePO_4$=1.4 g/g, 400 rpm and 30 min)

Figure S2

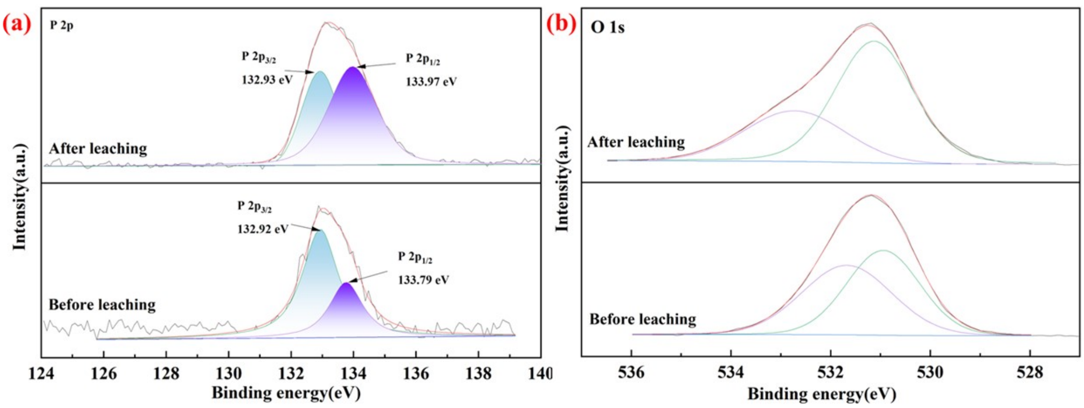

Figure S2. XPS spectra of (a) P 2p, and (b) O 1s for activated materials and leached residue (mass ratio of $Ca(ClO)_2/LiFePO_4$=1.2 g/g, 400 rpm and 30 min)

Table S2

Table S2. Purity of the LiCl standards and the products in our study.

Element	Industrial grade LiCl	In our study
Li	98.67%[a]	98.71%
Ca	1000[b]	987
Fe	1000	852
Na	500	450
Mg	10000	

Note: [a] Concentration in terms of mg metal/kg Li, ppm.

[b] Grams of Li/total grams of metal, excluding chlorides.

Text S1

Text S1. Economic analysis and detailed information

The spent $LiFePO_4$ batteries used in this study was obtained from Mizuda Group Co., Ltd. in Zhejiang Province, China. The spent $LiFePO_4$ batteries was disassembled, crushed and sorted to obtain 50 g of aluminum foil, 50 g of copper foil, 175 g of steel shell, 275 g of organic diaphragm and electrolyte, and 450 g of $LiFePO_4$ powder. Their economic values were calculated according to the economic analysis approach.

Process 1: According to the experimental design, 450 g of $Ca(ClO)_2$ was added to the $LiFePO_4$ powder for mechanical activation in a ball mill. After reacting for 30 min, 22.5 L of deionized water was added for the water leaching reaction. After the reaction, 408.5 g of leached residue and 21.38 L of leachate were obtained by vacuum filtration. The leachate was prepared by adding 293.2 g of ammonia carbonate to remove the impurity Ca, yielding 299.3 g of calcium carbonate. The Li-rich purification was evaporated/crystallized to obtain 110.66g of LiCl.

Process 2: According to the experimental design, 540 g of $Ca(ClO)_2$ was added to the $LiFePO_4$ powder for hydrometallurgical enhanced leaching. After reacting for 50 min, 408.5 g of $FePO_4$, 503.3g $CaSO_4$ and 3.85 L of leachate were obtained by vacuum filtration. The leachate was evaporated/crystallized to obtain 116.95g of LiCl crystalline matter.

Recently, the price of lithium salt has been fluctuating, and to determine the economic benefits and the inputs and outputs for different technical routes, the prices of the main reagents and products were normalized with the market price prevailing on January 31, 2023, as shown in Table S3. The exchange rate was calculated at 1 CNY = 0.14 USD. In addition, the powers of both the muffle furnace and the ball mill used in this paper were 3 kW. The energy costs, such as the electricity used in the comparative technology process, were based on the original literature, while this paper used the industrial electricity price of 0.8 RMB/kWh in Guangzhou, Guangdong Province, China.

Table S3

Table S3. Unit prices of the main chemical reagents/products.

Reagent/product (industrial grade purity)	Unit price ($/t)
$Ca(ClO)_2$	850
H_2SO_4	42
$FePO_4$/C	7700
$FePO_4$	2870
$(NH_4)_2CO_3$	280
$CaSO_4$	126
$CaCO_3$	70
LiCl	42000

Note: Data source reference: https://www.100ppi.com,https://b2b.baidu.com, https://p4psearch.1688.com, https://www.chemsrc.com.

Figure S3

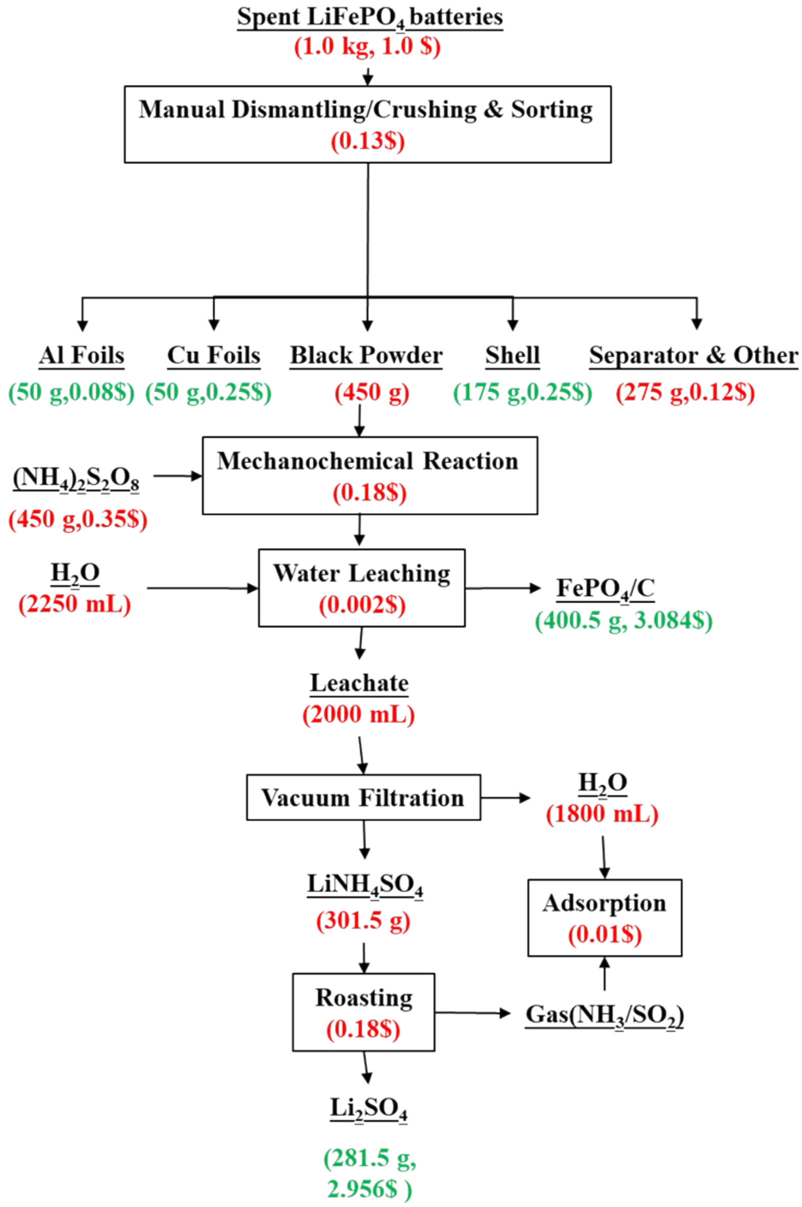

Figure S3. The benefits of recovering 1.0 kg spent LiFePO4 batteries in the persulfate system.