Supplementary information

Green Recycling of Spent Li-ion Battery Cathodes via Deep-Eutectic Solvents

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Supplementary Table 1. Summary of toxicity and biodegradability data for selected DESs.

DES	Molar ratio	Toxicity (mg L^{-1}, 30 min, by *Aliivibrio fischeri*)	Degradability (%)	Reference
ChCl	-	469		[1]
ChCl-acetic acid	1:2	130		
	1:1	197		
	2:1	337		
ChCl-lactic acid	1:2	30		
	1:1	62		
	2:1	67		
ChCl-glycolic acid	1:2	30		
	1:1	33		
	2:1	62		
ChCl-citric acid	1:2	16		
	1:1	22	81.6	
	2:1	32		
ChCl-urea	1:2	41693	97.1	[2]
	1:1	59825		
	2:1	69924		
ChCl-glycerol	1:2	104612	95.9	
	1:1	76726		
	2:1	90156		
ChCl-1,2-propanodiol	1:2	44048		[3]
	1:1	73492	82.6	
	2:1	61342		
ChCl-EG	1:2	41821	81.9	[2,4]
	1:1	67806		
	2:1	90343		

Note: The EC_{50} is effective concentration of antimicrobial agents, and a chemical is considered biodegradable if it reaches a biodegradation level > 60% within 28 days.

Supplementary Table 2. Progress on selective recovery of Li, Ni and Co from spent LIBs using DESs.

Cathode material	DESs	Metal with Selectivity	Recovery efficiency %	Recovered product	Reference
LCO	ChCl-EG 1:2	Co	90	CoC_2O_4	[5]
LCO; $Li_{3.2}Ni_{2.4}Co_{1.0}Mn_{1.4}O_{8.3}$	EG-tartaric acid (TA) 5:1	Li	98.34; 98.86	Li_2CO_3	[6]
LCO	ChCl-H_3PO_4 1:1	Co	87.7	$CoHPO_4$	[7]
LCO	ChCl-Glycerol 1:1.5	Co	95.7	Co_3O_4	[8]
LFP: NCM111 mass ratio of 1:1	ChCl-FA 1:1 combined with mechano- chemical induction	Li	97.6	Li_2CO_3	[9]
LCO	ChCl-EG-benzoic acid 1:1.6:0.4	Co	99.99	-	[10]
LCO	Formic acid (FA); ChCl-FA 2:1	Li; Co	99.8; 99.0	Li_2CO_3; $CoCO_3$	[11]
NCM532	ChCl-OA 1:1	Ni	-	NiO or NiC_2O_4	[12]
NCM811	ChCl-OA 1:1	Ni	99.1	$NiC_2O_4 \cdot 2H_2O$	[13]
LFP	EG-CC 8:1 combined with O_3	Li	92.2	LiCl	[14]

Note: "-" denotes "no data available".

Supplementary Table 3. Price of some chemicals used in preparation of DESs (www.alibaba.com).

Chemical	**Price (USD$ kg^{-1})**
ChCl	7.8
H_2O	0.5
Oxalic acid (OA)	3.75
DES ChCl-OA 1:1	6.06
DES ChCl-OA 1:2	3.58
DES ChCl-OA 1:5	4.60
DES ChCl-OA 1:1 + 25wt% H_2O	4.68
Acetic acid (AA)	0.8
DES ChCl-AA 1:1	5.46
DES ChCl-AA 1:2	4.29
DES ChCl-AA 1:5	2.79
Formic acid (FA)	0.65
DES ChCl-FA 1:1	5.81
DES ChCl-FA 1:2	4.69
DES ChCl-FA 1:5	3.09
Lactic acid (LA)	2.1
DES ChCl-LA 1:1	5.35
DES ChCl-LA 1:2	4.37
DES ChCl-LA 1:5	3.30
Urea	0.25
DES ChCl-Urea 1:1	5.28
DES ChCl-Urea 1:2	4.02
Ethylene glycol (EG)	1.5
DES ChCl-EG 1:1	5.65
DES ChCl-EG 1:2	4.74
Maleic acid	15
Citric acid	2
Tartaric acid	10
Succinic acid	5.3
Phytic acid	22.0
PEG	1.0
BeCl	1.0
TOPO	2.0
Guanidine hydrochloride	5.0
H_3PO_4	2.5
HCl	54
HNO_3	58

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