

Supporting Information

Eco-friendly and low-cost removal of bromine from waste printed circuit boards smelting ash by mechano-chemical leaching

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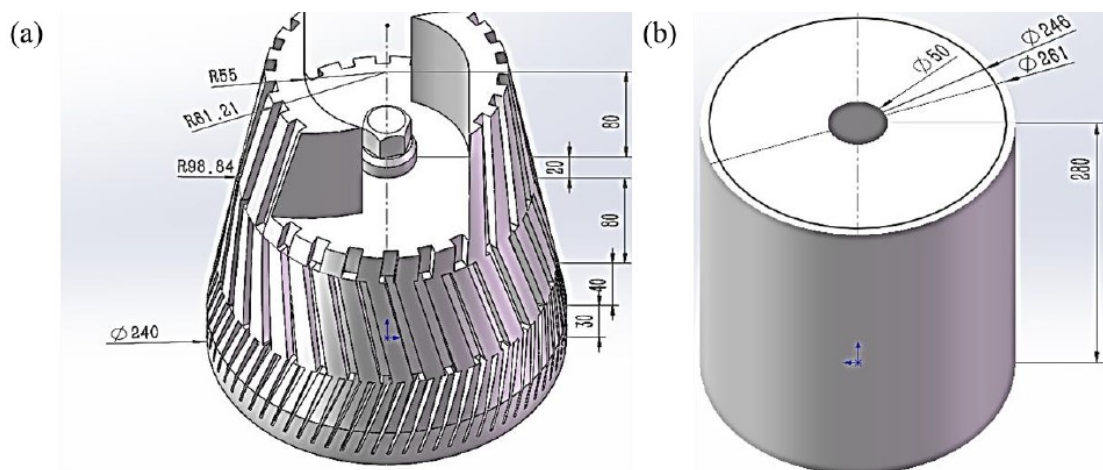


Fig. S1. The geometric model of the main structure of RS-RR: (a) rotor and (b) stator.

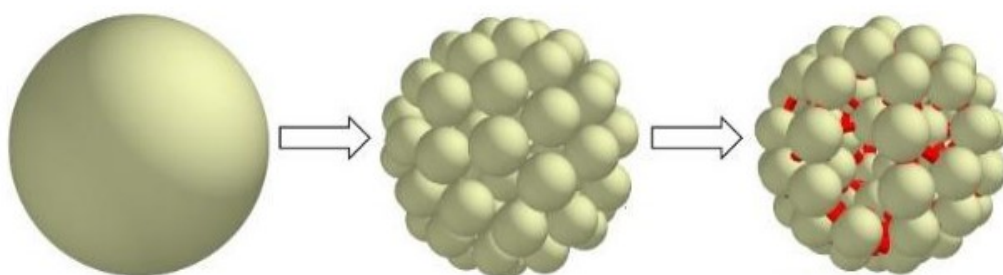


Fig. S2. The particle replacement model.

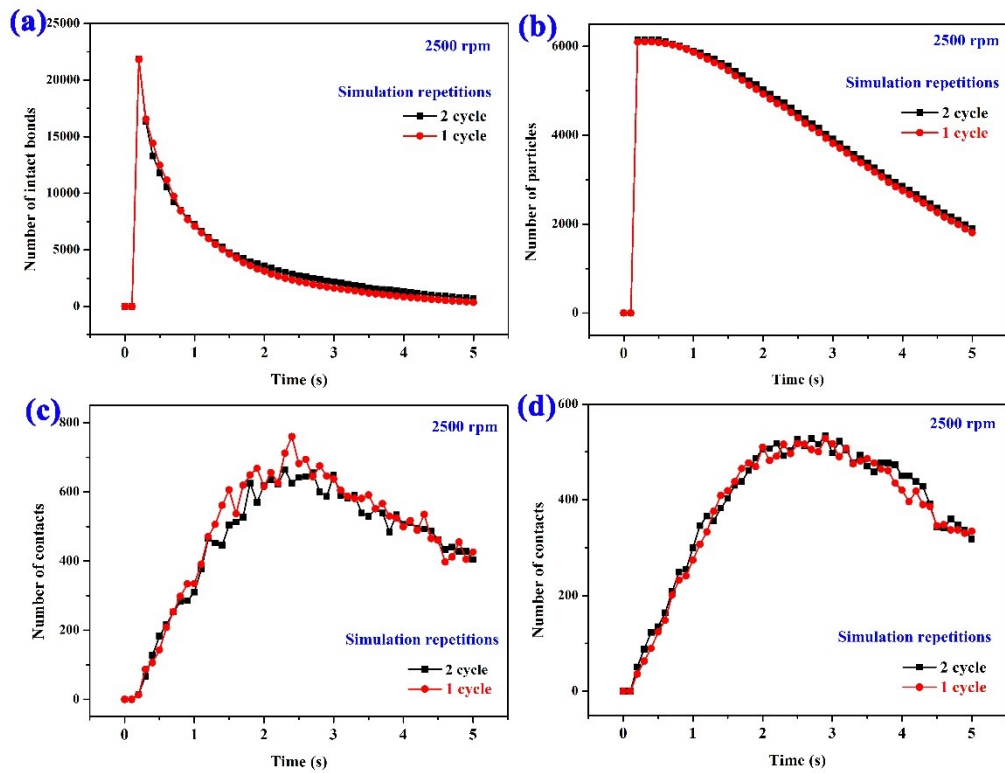


Fig. S3. Simulation duplicate data at 2,500rpm: (a) the number of intact bonds; (b) the number of fraction particles; (c) the number of particles in contact with the static grinding disc; (d) the number of particles in contact with the moving grinding disc.

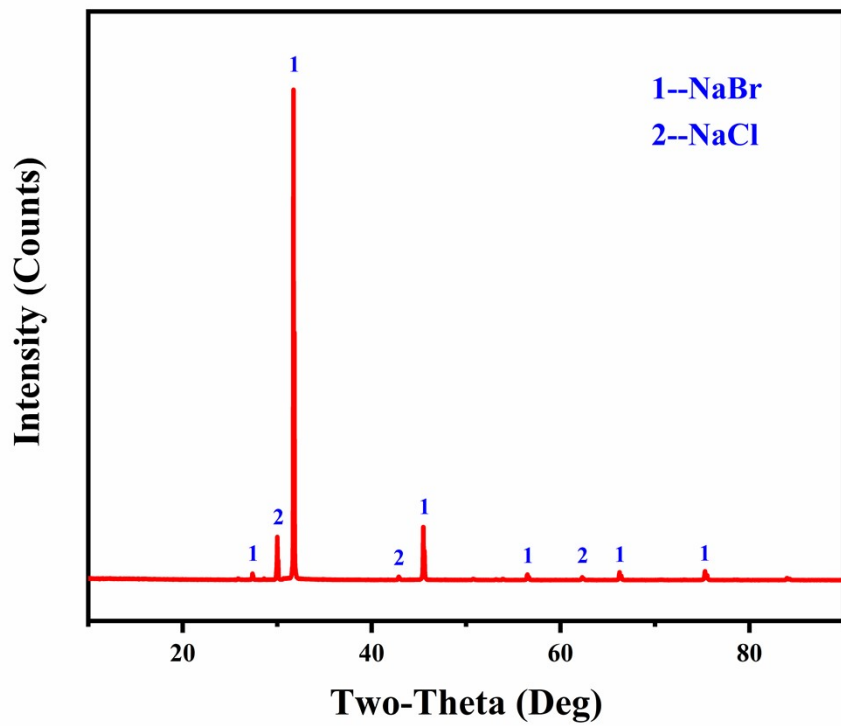


Fig. S4. The XRD patterns of mixed salt.

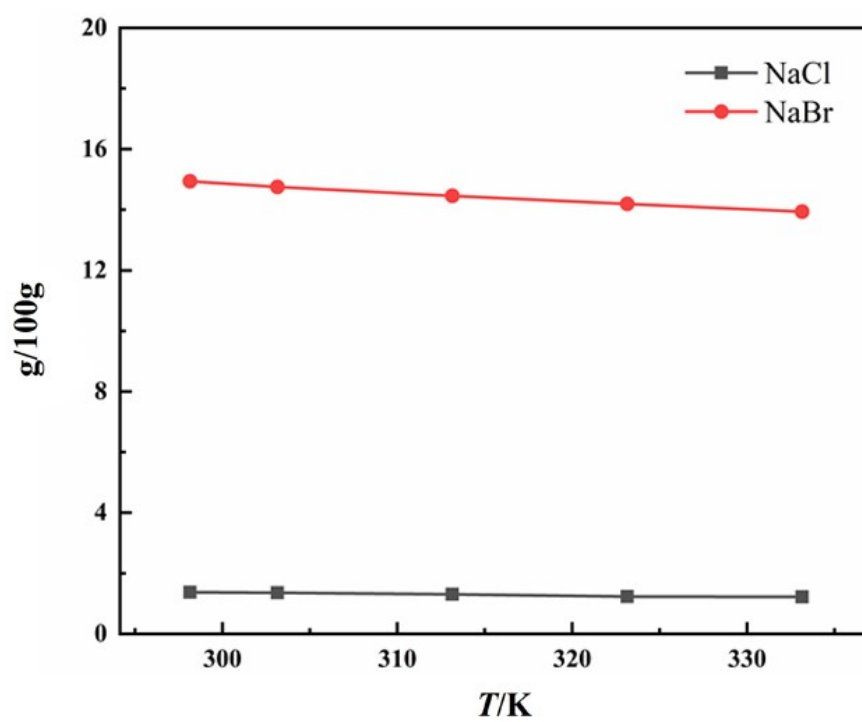


Fig. S5. Solubility of NaBr and NaCl in methanol.

Table S1. Simulation conditions

EDEM			
Time step (s)	3.70×10^{-7}	Poisson ratio	0.3
Calculation time (s)	5	Shear modulus (Pa) for particle	2.11×10^{10}
Whole particle diameter (mm)	20	Shear modulus (Pa) for contact media	1.01×10^{11}
Fraction particle diameter (mm)	3	Coefficient of Restitution of particle	0.1
Particle density (kg/m ³)	2,790	Coefficient of Static Friction of particle	0.545
Device material density (kg/m ³)	7,890	Coefficient of Rolling Friction of particle	0.01
Mesh size (mm)	3	Cell number	1.54×10^6
FLUENT			
Fluid density (kg/m ³)	998.2	Dynamic viscosity (Pa·s)	1.03×10^{-3}
Fluid velocity (m/s)	5	Cell number	1.69×10^6
Turbulence intensity inlet (%)	5	Residual	1.0×10^{-4}
Particle density (kg/m ³)	1,200	Particle diameter (μm)	50
Particle velocity inlet (m/s)	5	Particle flow rate (kg/s)	0.0001
Cell number of mesh	1,694,031	Average element quality	0.83454
Gravity (m/s ²)	9.81	Minimum cell volume	8.94×10^{-13}

Table S2. Percentage distribution table of fluid velocity in flow field at different rotation speeds

500 rpm		1,000 rpm		1,500 rpm		2,000 rpm		2,500 rpm	
Velocity(m/s)	%	Velocity(m/s)	%	Velocity(m/s)	%	Velocity(m/s)	%	Velocity(m/s)	%
0-1.94	4.24	0-3.14	5.58	0-4.84	5.50	0-6.43	6.02	0-8.02	6.41
1.94-3.86	39.80	3.43-6.84	15.79	4.84-9.65	8.92	6.43-12.80	5.80	8.02-16.02	4.42
3.86-5.77	28.21	6.84-10.25	37.05	9.65-14.47	25.81	12.80-19.16	23.08	16.02-24.01	22.36
5.77-7.68	27.59	10.25-13.66	41.51	14.47-19.28	59.50	19.16-25.53	64.87	24.01-32.00	66.68
7.68-9.59	0.16	13.66-17.07	0.07	19.28-24.10	0.27	25.53-31.89	0.23	32.00-40.00	0.13

Table S3. Comparison of various technologies for dissolution of insoluble bromides in WPCBs-SA.

Technologies	Insoluble bromides	Optimal parameters	Toxic gas emissions	Br removal yield	Refs.
H ₂ SO ₄ roasting	CuBr, PbClBr	Acid/WPCBs-SA of 0.8g/g, temperature of 316.89 °C, roasting time of 123.25 min	HBr/Br/SO ₂	98.97%	1,2
NaOH leaching	CuBr, PbBr ₂	NaOH concentration of 2 mol/L, L/S ratio of 12:1 mL/g, stirring rate of 600 rpm, temperature of 70 °C, leaching time of 120 min	\	96.39%	3
Mechano-chemical leaching	PbBr ₂ , PbClBr	NaOH concentration of 4.5 mol/L, L/S ratio of 3:1 mL/g, rotation speed of 2500 rpm, grinding disc gap of 3 μm, leaching time of 20 min, room temperature	\	96.76%	This work

References

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