A green and efficient strategy for leaching critical metals from spent $LiNi_xCo_yMn_zO_2$ cathodes: Modulating the dielectric SiO_2 contact-electro-catalytic activity

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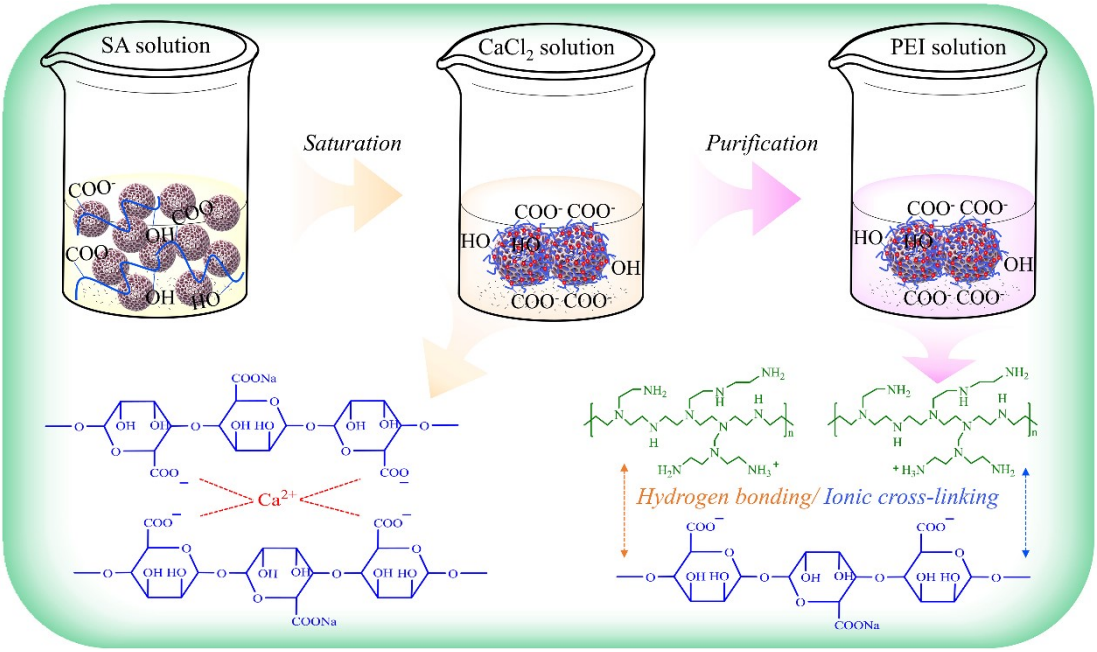

Fig.S1 Schematic diagram of the fabrication of $SA@SiO_2$ and $PEI\text{-}SA@SiO_2$ microspheres.

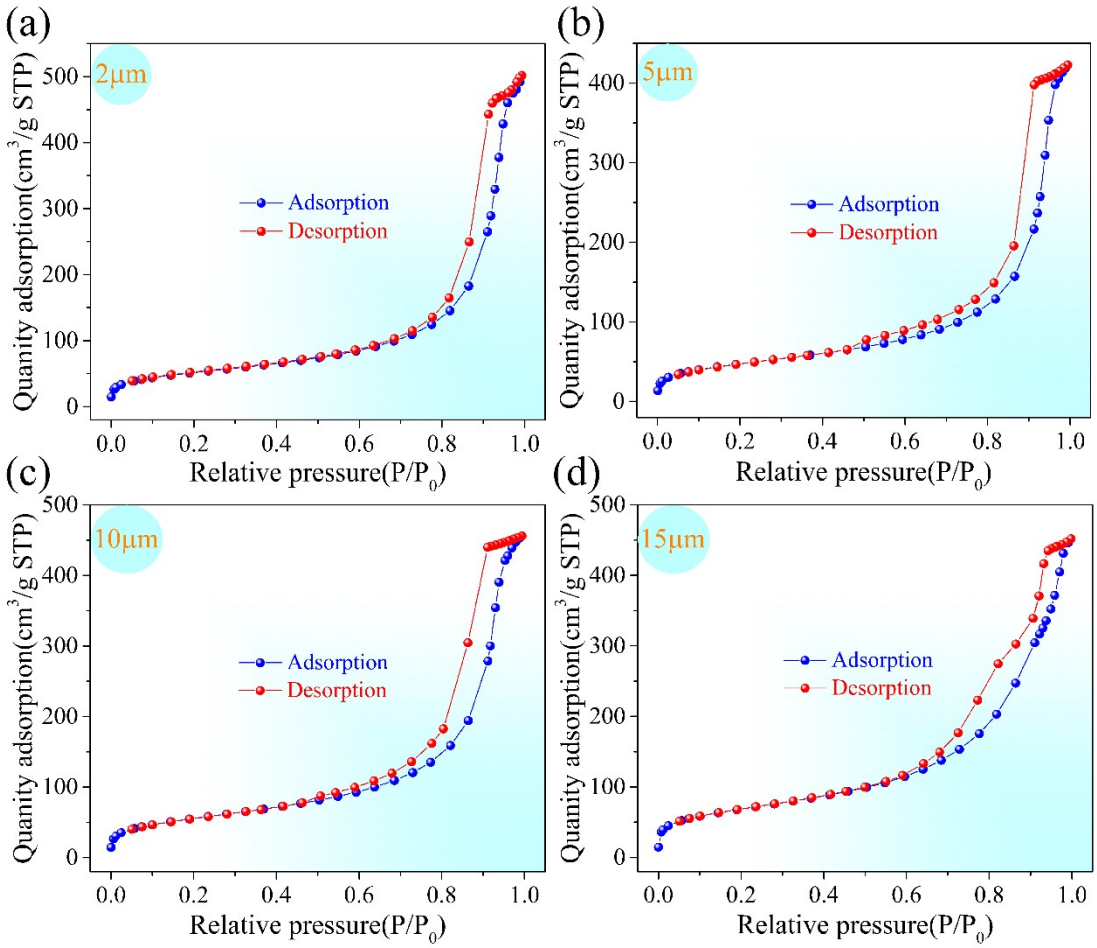

Fig.S2 BET adsorption and desorption isotherms of 2μm (a), 5μm (b), 10μm (c) and 15μm (d) porous SiO_2 microspheres.

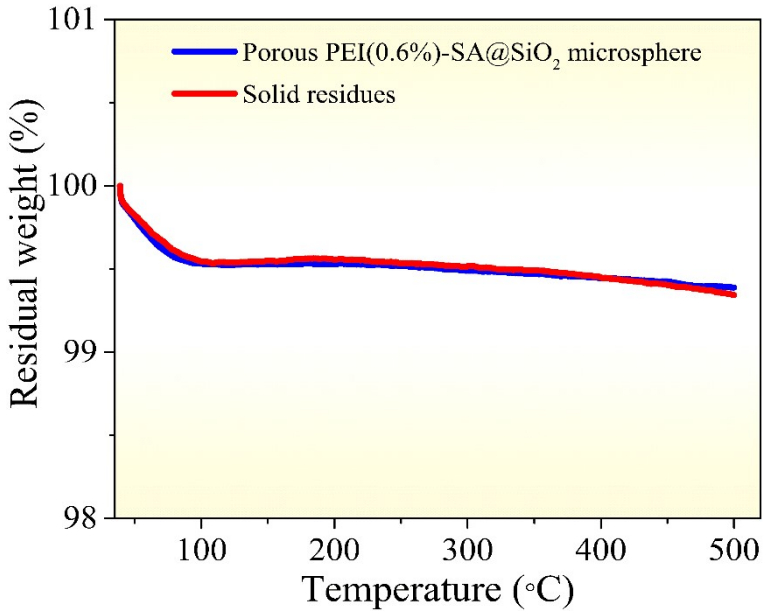

Fig.S3 TGA curves of PEI(0.6%)-SA@ SiO_2 microspheres and purified solid residues.

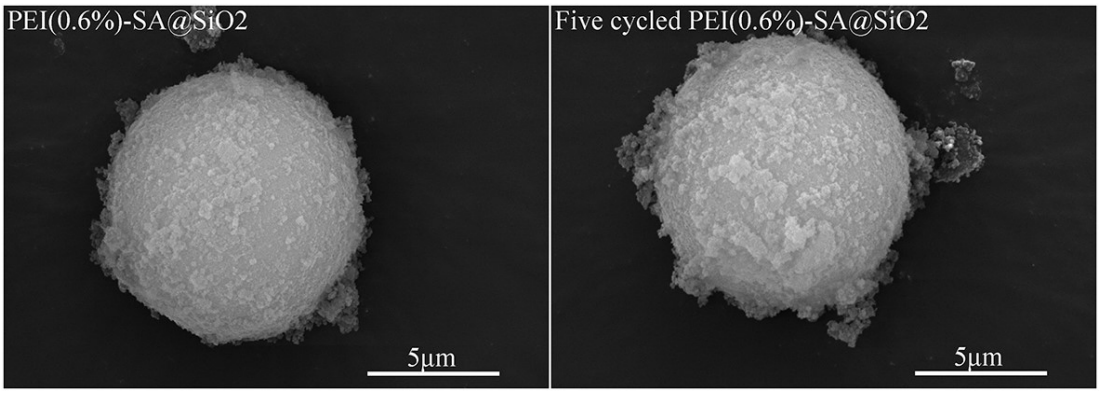

Fig.S4 SEM images of PEI(0.6%)-SA@SiO_2 microspheres before and after five leaching cycles.

Economic analysis:

An economic assessment was performed on the proposed process, with 1 kg of spent $LiNi_xCo_yMn_zO_2$ powder as the basis for calculation. While the technology is considered highly scalable, we have taken a conservative approach in estimating consumption to ensure robustness for potential large-scale deployment.

Assumed Conditions:1 $=7.12 RMB, 1 kWh=0.2 $, 1 t industrial water = 0.91 $.

1. Material cost

The total cost for 0.12 g of PEI (0.6%)-SA@SiO_2 microspheres was calculated to be 8.453 $. This cost comprises SiO_2 microspheres ($8.43, 70.22 $/g), SA ($0.0087, 0.058 $/g), PEI ($0.0102, 0.17 $/g), and $CaCl_2$ ($0.0039, 0.007 $/g);

50 L 0.2 mol/L $C_6H_8O_7 \cdot H_2O$ (0.00466 $/g): 9.79 $;

50 L H_2O:0.0455 $;

2. Energy consumption

Ultrasonic machine + heating:200W*0.5h+600*8h=4.9 kWh=0.98 $.

3. Total costs

Total energy cost + Total material cost=8.453 $ + 9.79 $ + 0.0455 $ + 0.98 $= 19.27.