Title: A novel process for leaching of metals from $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ material of spent lithium ion batteries: Process optimization and kinetics aspects

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A novel process for leaching of metals from $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ material of spent lithium ion batteries: Process optimization and kinetics aspects

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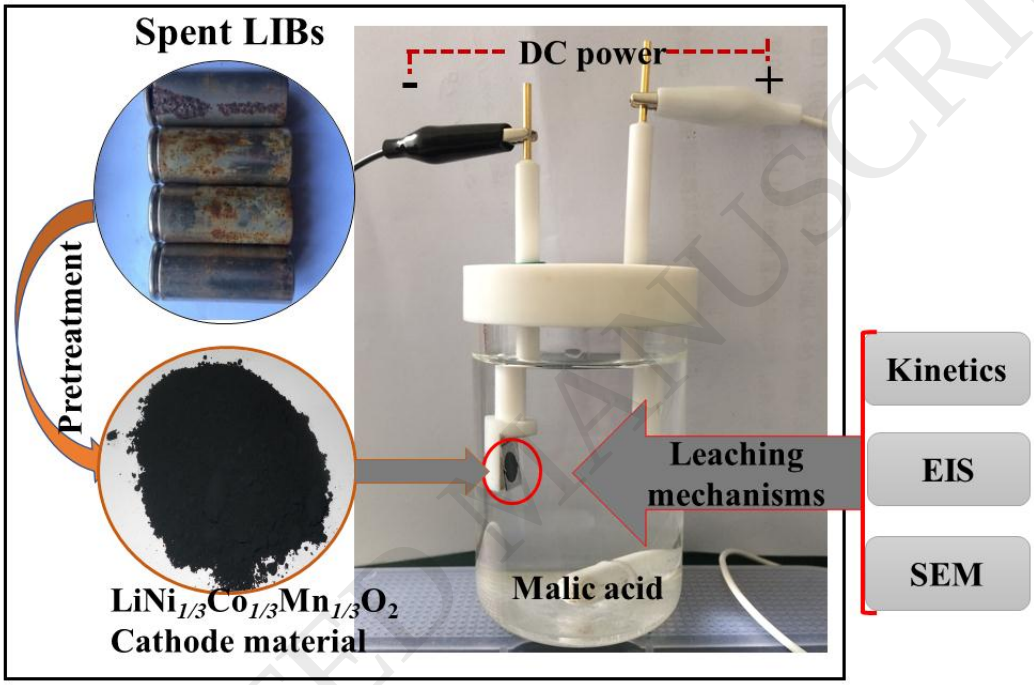
Graphical abstract



Highlights:

- The novel process of electrochemical cathode reduction is designed for leaching of valuable metals from spent $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ material.
- The thermodynamics and kinetics are analyzed for leaching process.
- The EIS and SEM are used to for analysis of leaching mechanisms.
- Leaching efficiencies of Li, Ni, Co and Mn reach to 100, 99.87, 99.58 and 99.82%, respectively.

ABSTRACT: A novel process of electrochemical cathode reduction has been developed for leaching of metals from spent $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ material. The leaching efficiencies of Li, Ni, Co and Mn reached to 100, 99.87, 99.58 and 99.82%, respectively with 1.5 mol/L malic acid and working voltage of 8 V at 300 r/min and 60 °C for 30 min. Kinetics analysis indicates that leaching process is controlled by surface chemical reaction. The E_a for Li, Ni, Co and Mn was 41.71, 42.83, 44.38 and 43.17kJ/mol, respectively. Based on EIS analysis, leaching process is mainly controlled by charge transfer resistance of the surface chemical reaction.