Sustainable Lithium-Ion Batteries: New Strategies for Aqueous Cathode Production

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Due to the ongoing climate crisis, the modern world continues to experience an ever-growing demand for reliable and high-performance energy storage systems. Lithium-ion batteries (LIB) based on high-nickel layered metal oxides represent the current state of the art for applications requiring high energy densities, such as electric vehicles. At present the LIB cathode production still relies on PFAS-emitting fluorinated polymers processed with toxic N-methyl pyrrolidone. Attaining greener processes, improved recyclability, and achieving an overall transition to sustainability requires the adoption of water-soluble polymers and aqueous processing.

Whilst in theory, water-soluble electrode binders have been developed, the combination with high-nickel active materials still poses several problems. The most crucial consequence of adding the active material into an aqueous electrode slurry is the subsequent increase in pH due to Li^+-ion leaching and formation of lithium hydroxide. This causes corrosion of the aluminum current collector and decreases the battery lifetime. Researchers and industry have previously tried to mitigate this by adding acids to the electrode slurry, which appears beneficial in controlling this effect. [2]

This research presents an alternative strategy to solve the “pH problem” of aqueous cathode processing for LIB, aiming to reduce the need for additional acidic additives. Specialty monomers, polymers, and a novel reactive coating process are combined to improve the electrode manufacturing. Processing of the electrode slurry systems and reactive coating tests were conducted. The behaviour of the active cathode material (NMC) in water is studied in-depth by examining influencing factors such as pH, lithium ion leaching, and other crucial processing parameters. These combined results seek to reduce and optimize process steps and enable a new energy-saving and environmentally friendly method for producing electrodes for sustainable LIBs.

Keywords: Lithium-ion batteries, aqueous processes, cathodes, polymeric binders, sustainable electrode binders

References

[1] Hofmann M.; Kapuschinski M.; Guntow U.; Giffin G.A. Implications of Aqueous Processing for High Energy Density Cathide Materials: Part I. Ni-Rich Layered Oxides. *J. Electrochem. Soc* **2020**, *167*, 140512.
[2]Tolchard J.R.; Vullum P.E.; Arstad B.; Wagner N.P. New insights into orthophosphoric acid assisted rapid aqueous processing of NMC622 cathodes. *RSC Sustain*. **2023,** *1*, 378-387.