Developing zwitterionic binder systems for water-processable lithium-ion battery cathodes with high voltage stability

Marie Uth[1]
[1]Aarhus University, , Denmark

Most commercial lithium-ion batteries rely on polyvinyl difluoride (PVDF) binders despite increasing demands for sustainable manufacturing and improved safety. The environmental risks associated with polyfluoroalkyl substances (PFAS) and the need for toxic solvents to process fluorinated binders have motivated the search for alternative binding concepts with greener profiles.

This work investigates zwitterionic polymer binders as water-processable, fluorine-free alternatives to PVDF. The polymers incorporate both cationic and anionic functional groups, enabling aqueous electrode processing while promoting ionic coordination with lithium ions and strong adhesion to metal oxide particles and current collectors. These interactions are expected to enhance electrode integrity and reduce interfacial resistance. Zwitterionic polymers have previously demonstrated potential as solid electrolyte materials, raising the possibility of multifunctional binder–electrolyte systems for next-generation lithium-ion batteries.

The presentation outlines the journey in design and development of zwitterionic binder materials, including evaluation of solubility, mechanical properties, ionic transport, and electrochemical stability. The study establishes structure–property relationships governing binder performance and demonstrates how binder chemistry can improve the electrochemical battery performance as well as the environmental profile of lithium-ion batteries.