POST LI-ION BATTERIES

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Lithium-ion batteries dominate the market for portable electronic devices and for electric vehicles. Today, battery research is driven by the need to extend the operating time of portable devices, longer charging intervals, longer ranges and faster charging for electric vehicles. In addition to higher energy and power density, goals include operational reliability and extended lifetime while reducing costs and environmental impact.
Lithium-ion technology has matured to a point where leapfrog improvements are no longer expected. Post lithium-ion technologies such as lithium-air, lithium-sulfur, sodium-ion, and solid-state batteries promise to advance energy densities due to the use of metal anodes and lower cost due to the use of cathode active materials consisting of earth abundant elements.
In this presentation, we will review selected post-lithium ion batteries, with a special focus on sodium all-solid-state battteries featuring hydroborate-based solid electrolytes. These electrolytes combine high ionic conductivity at room temperature ($\geq$1 mS cm^{-1}), compatibility with metal anodes and high voltage cathodes. We demonstrated stable cycling of hydroborate-based solid-state battery consisting of a $Na_3(VOPO_4)_2F$ cathode versus a Na anode with 78% capacity retention after >800 cycles at C/5. This cell records the highest average discharge voltage (3.8 V) and specific energy at the active material level (445 Wh kg^{-1}) reported for sodium all-solid-state batteries.
Despite these promising results, all post-lithium technologies face their individual challenges. Kinetic limitations are a common hurdle that need to be overcome and competitive cathode active materials have to be developed to enable the success of post-lithium-ion technologies. For the near future Li-ion batteries will continue to dominate the market. The race for a follow-up technology is open.

References

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Arndt Remhof is a group leader at Empa in the Laboratory Materials for Energy Conversion where his research focus lies on the development of novel ionic conductors for the application in all solid-state batteries. He studied physics in Bochum (Germany) and in Canterbury (UK). He obtained his diploma-degree at the Institute Laue-Langevin in Grenoble (France) and his PhD from the Ruhr-University in Bochum (Germany). He published more than 150 papers, organized several conferences and is member of the scientific advisory board of the Paul Scherrer Institute. He obtained his Venia Legendi in 2019 from the University in Freiburg, Germany.