Post-lithium Ion Batteries

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Abstract

Lithium-ion batteries (LIBs) are well-accepted advanced power sources in a variety of domains of our everyday activity (from portable devices to electric vehicles and large-scale energy storage devices). The foreseen exponential increase of batteries in different domains has resulted in concerns over the lithium availability, price, and potential geopolitical tensions related to its distribution. Additionally, the energy density of the current Li-ion technology is still inadequate to meet ever-growing demands for energy storage. Most of the roadmaps that are publicly available predict the development of novel redox chemistries. In the short term, the focus is on the development of lithium metal batteries and solid-state electrolytes, while in the long term, there is a need for development of sodium-, potassium-, magnesium-, calcium-, zinc- or even aluminum batteries, based on earth-abundant resources.

Currently, the development of novel concepts based on more sustainable materials that enable improved energy density (volumetric and gravimetric) is required. This can be achieved through a combined experimental and computational approach, with research activities focused on the design of stable active materials with well-controlled interfaces, and enabling fast transport within all of the battery components. Several novel redox chemistries have been developed in research laboratories and companies over the world, which can potentially enable high energy densities beyond current Li-ion batteries. These include the development of room temperature sodium and potassium batteries, which enable manufacturing processes close to those of Li-ion batteries. In addition, alternative battery chemistries based on the multivalent cations are typically based on the use of metal anode coupled with the sustainable cathode (oxygen, sulfur, organic carbonyl electrodes, and metal/covalent organic frameworks-derived materials).

In this session, we will survey some of these most promising research directions in post-Li-ion batteries. Matthew T. McDowell from the Georgia Institute of Technology will open the session with a talk related to the development of all-solid-state batteries with metallic lithium as an anode material. This talk will be followed by from Jan Bitenc from the National Institute of Chemistry, Slovenia, who is working on multivalent batteries. These batteries include magnesium, calcium, and aluminum metal anodes coupled with different types of sustainable cathode materials. Next, Nagore Ortiz Vitoriano from the CIC Energigune in Spain will show the challenges and benefits of having air as an electrode. The final speaker is Partha Mukherjee from Purdue University, who will show how modeling approaches can accelerate the development of novel battery materials and redox chemistries.

Speakers

Solid-state Batteries for Electromobility
Matthew T. McDowell, Georgia Institute of Technology, USA
https://mtmcdowell.gatech.edu/bio

Multivalent Metal (Mg, Ca, Al) Anode Batteries as a Future High-energy Alternative to Li-ion
Jan Bitenc, National institute of Chemistry, Ljubljana, Slovenia
https://www.researchgate.net/profile/Jan-Bitenc

Unlocking the Potential of Aqueous and Aprotic Metal-air Batteries
Nagore Ortiz Vitoriano, CIC Energigune, Spain
https://cicenergigune.com/en/nagore-ortiz-vitoriano
https://cicenergigune.com/en/metal-air-batteries

"There's Plenty of Room in the Middle": A Mechanistic Perspective for Beyond Lithium-ion Batteries
Partha Mukherjee, Purdue University, USA
https://engineering.purdue.edu/ME/People/ptProfile?resource_id=173050