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Introduction: Beyond Li-Ion Battery Chemistry

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Global Collaboration for Better Batteries

Electricity changed forever with the invention of new batteries more than 220 years ago. Batteries enable humankind to store, transport, and use electricity on demand, anytime, anywhere. Without such a storage solution, electrons must be consumed when they are generated. If we pay close attention to the history of the battery, its exciting progress and development coincides with the industrial revolution which started around the same period of time (mid 18th century). Today, we see energy storage enabled by advanced materials and their chemistries making inroads in three key areas: first, wearable devices that demand batteries of flexible shapes and forms; second, high power and high energy batteries that enable long-range driving (>300 miles per charge) and fast charging (<30 min for 80% state of charge) for electric vehicles; and third, low cost and long life batteries that store electrons from renewables at industrial scales (MWh to GWh scale). It is an exciting time—more scientific and technological breakthroughs are on the horizon, and the field has been further energized by the 2019 Nobel Prize in Chemistry awarded to Prof. Stanley Whittingham, Dr. Akira Yoshino, and Prof. John B. Goodenough.

In this thematic issue of *Chemical Reviews*, we received 14 contributions from nine different countries, with topics ranging from new chemistry for batteries (calcium[1] and potassium[2] ion batteries), organic aqueous[3] and nonaqueous[4] batteries, lithium air[5]/oxygen[6] batteries, novel nanoscale phenomena for redox electrochemistry,[7,8] novel electrolytes,[9] solid state batteries,[10,11] metal anode batteries, and new approaches to study interfacial phenomena.[12] At the atomistic level, challenges in theory and computational approach are reviewed,[13] yet at the system level, sustainable recycling technologies for new battery chemistries are highlighted.[14] These contributions reflect the fact that researchers all over the world are searching for better batteries that can lead to a better future for humankind. These articles also showcase the tremendous challenges to develop such new batteries that do better than today's lithium ion batteries (LIB). From the atomistic scale, to microstructure, mesoscale materials optimization, and new architectures for system level redesign, the complexity of a battery system requires close collaborative efforts from physicists, chemists, electrochemists, materials scientists, engineers, and field practitioners. Only through global collaboration where the key knowledge and critical insights are shared can we make more breakthroughs in energy storage chemistries!

Y. Shirley Meng

AUTHOR INFORMATION

Complete contact information is available at:
https://pubs.acs.org/10.1021/acs.chemrev.0c00412

Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.

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(2) Research Development on **K-Ion Batteries**
(3) Electrolyte Lifetime in **Aqueous Organic Redox** Flow Batteries: A Critical Review
(4) Opportunities and Challenges for **Organic Electrodes** in Electrochemical Energy Storage
(5) Current Challenges and Routes Forward for **Nonaqueous Lithium−Air** Batteries
(6) **Lithium−Oxygen** Batteries and Related Systems: Potential, Status, and Future
(7) **Nanoscale Phenomena** in Lithium-Ion Batteries
(8) **Pseudocapacitance:** From Fundamental Understanding to High Power Energy Storage Materials
(9) New Concepts in **Electrolytes**
(10) Approaching Practically Accessible **Solid-State Batteries:** Stability Issues Related to Solid Electrolytes and Interfaces
(11) **Interfaces and Interphases** in **All-Solid-State** Batteries with Inorganic Solid Electrolytes
(12) Exploring **Anomalous Charge Storage** in Anode Materials for Next-Generation Li Rechargeable Batteries
(13) Rechargeable Alkali-Ion Battery Materials: **Theory and Computation**
(14) Sustainable **Recycling Technology** for Li-Ion Batteries and Beyond: Challenges and Future Prospects

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