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*Editorial*

# Battery technologies: lithium & beyond

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Global efforts to mitigate climate change are causing a transition from non-renewable energy resources (fossil fuels) to renewable energy resources (wind, solar, hydroelectricity, geothermal). This energy transition to sustainably meet the world's growing needs for electricity, heating, cooling, and power for transport is widely considered to be one of the biggest challenges facing humanity in this century. The transition is enabled by improvements in generation and storage technologies critical to harvesting inherently intermittent renewable energy. Moreover, growing needs for smaller, lighter, more powerful portable electronic devices and more powerful electric vehicles suitable for long-range transportation have further fostered the demand for dispatchable and efficient electrical energy storage. These have catalyzed rapid development and commercialization of high-energy and lightweight rechargeable batteries, primarily based on lithium. However, lithium-enabled rechargeable batteries are plagued with challenges such as uncontrolled surface/interface (low safety), sluggish transport & reaction kinetics (slow charging), & relatively rare abundance of the metal (high cost). Moving beyond lithium necessitates the development of safe & fast-charging rechargeable batteries based on relatively abundant metals (*i.e.* Na, Zn, Al, Fe, *etc*.).

This special issue discusses (a) the genesis and current state of lithium-ion batteries bridging chemistry to commercial applications (Le, *A general introduction to lithium-ion batteries: From the first concept to the top six commercials and beyond*) (b) material chemistries that enable next-generation lithium-ion electrodes of high performance and energy densities (Pavitra *et al.*, *Brief review on carbon derivatives based ternary metal oxide composite electrode materials for lithium-ion batteries*) (c) fundamental understanding of anode and cathode reaction pathways that dictate lithium ion-battery performance (H. Dasari, E. Eisenbraun, *Predicting the effect of silicon electrode design parameters on thermal performance of a lithium-ion battery* and M. Sakai, *Cathode reaction models for Braga-Goodenough Na-ferrocene and Li-$MnO_2$ rechargeable batteries*) (d) electro-chemically inactive precursors and coatings that can enhance the performance of lithium electrodes and therein the battery performance across rate capability and longevity (C. Cai *et al.*, *Impact of carbon coating processing using sucrose for thick binder-free titanium niobium oxide lithium-ion battery anode*) and (e) battery material processing and doping techniques that enhance the energy density and cyclability of the lithium-ion battery K. Elong *et al.*, *Annealing effect on structural and*

*electrochemical performance of Ti-doped $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ cathode materials*). In summary, this issue aims to provide the readers with a fundamental understanding of lithium battery technology, from material chemistry to commercial applications, that enables the readers to endeavor in their discovery of next-generation batteries.

This issue is a tribute to Peter Faguy (1956 - 2022), a true scientist, a teacher, and a friend who led translational R&D programs to commercialize battery technology for electric vehicles. He was proud and determined to develop the future of renewable energy for the entire world. Many people think he has done this; if not, it was only a matter of time.