Multifunctional Composite Designs for Structural Energy Storage

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June 27, 2023

Abstract

Structural batteries have emerged as a promising alternative to address the limitations of conventional batteries, with the potential to integrate energy storage into stationary constructions or mobile vehicles/planes. Developing multifunctional composites is effective to realize the structural plus concept, which can reduce the inert weight and improve the performance of the energy storage beyond the material level (e.g., cell- or system-level). Specifically, multifunctional composites in structural batteries can work as both a functional composite electrode to store charges and a structural composite to bear mechanical loads. However, they suffer from the trade-off between mechanical properties and energy storage performance due to the scientific challenges of unstable interfaces and the lack of viable manufacturing approaches. In this review, we first introduce recent research developments of electrodes, electrolytes, separators, and interface engineering specific to structure plus composites for structure batteries, and then summarize the mechanical and electrochemical characterizations. We discuss in detail the reinforced multifunctional composites for structure batteries, the exploration of multifunctionalities on different composite structures and battery configurations, and then conclude with a perspective on future opportunities. The knowledge synthesized in this review contributes to the advancement of this field and facilitates the realization of efficient and durable energy storage systems integrated into structural components.

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