Atomic-Level Manipulation of Multivalent Ion Intercalation Materials for High-Density Energy Storage
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Energy density and safety are key elements to transportation batteries, which are required to be weight/space efficient and should sustain harsh environments. Batteries based on multivalent metal cations, such as rechargeable magnesium batteries, are a promising technique for the pursuit of ultra-high-density energy storage which will deliver over four times higher volumetric energy densities than those of state-of-the-art lithium-ion batteries. Since multivalent cations are typically highly polarizing, they form large complex ions with solvent molecules and have strong electronic interaction with intercalation host materials, leading to inferior electrode performance.

In this talk, I will present a general methodology of tailoring established lithium-intercalation hosts for multivalent metal cations. By combining theoretical modeling, chemical engineering, and electrochemical characterization, we have demonstrated that the ion intercalation and diffusion kinetics can be effectively improved by atomic-level manipulation of intercalation materials. This strategy enables a family of electrode materials for intercalation of multivalent cations, which are previously perceived as not suitable for the purpose.