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Abstract

Magnesium-sulfur (Mg-S) batteries are highly attractive because of their high theoretical energy density, low cost and safety features. However, severe capacity fading issues limit their development, which are greatly associated with reaction processes at electrode/electrolyte interfaces. Herein, we systematically studied the interfacial processes of Mg deposition/stripping in ether-based electrolytes at nanoscale by *in situ* atomic force microscopy (AFM). It can be directly observed the initial nucleation of bowl-like structure and deposition of crystallized Mg upon charge in tetraglyme (TEG) - based electrolyte, followed with uniform stripping process upon discharge. In contrast, the initial nucleation of bowl-like structure, fast stack of nanoparticles (NPs) and deposition of crystallized Mg upon charge can be observed in diglyme (DEG) - based electrolyte, followed with nonuniform stripping process upon discharge. Combined with *in situ* optical imaging, former system shows better reversibility upon cycle.

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