Direct observation of redox mediator-assisted solution phase discharging of Li-O_2 battery by liquid phase transmission electron microscopy

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Li-O_2 battery is one of the promising next-generation energy storage systems as it can potentially offer the highest theoretical energy density among battery chemistries. However, realization of its high discharge capacity still remains challenging by the formation of discharge products causing premature passivation of the air electrode. Herein, we attempt to monitor the discharge reaction of a Li-O_2 battery with redox mediator which is one of the approach to solve the problem by promoting the charge transfer from electrodes to the solution phase in real time by liquid phase transmission electron microscopy (TEM). Direct observation reveals the gradual growth of toroidal Li_2O_2 discharge product in the electrolyte. Moreover, quantitative analyses of the growth profiles elucidate that the growth mechanism involves two steps: dominant lateral growth of Li_2O_2 into disc-like structures followed by vertical growth with morphology transformation into a toroidal structure.