Carbon-Free Cobalt Oxide Cathodes with Tunable Nanoarchitectures for Rechargeable Lithium-Oxygen Batteries

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Rechargeable lithium-oxygen (or lithium-air) batteries are expected to have energy densities several times higher than those of state-of-the-art lithium-ion batteries [1]. If successfully developed, therefore, they could enable electric vehicles with driving ranges similar to those of gasoline-powered vehicles. In general, a Li-O_2 battery consists of a Li metal anode, a liquid Li^+-conducting electrolyte, and a porous cathode (oxygen electrode). Based on the liquid electrolyte used, Li-O_2 batteries may be classified into (*i*) non-aqueous aprotic, (*ii*) aqueous, and (*iii*) mixed (or hybrid) non-aqueous/aqueous systems. A greater focus has been on a non-aqueous system, due to its higher energy density compared to other systems.

Carbon is the most widely used cathode material for non-aqueous Li-O_2 batteries. During discharge-charge cycles, however, carbon becomes unstable and promotes electrolyte decomposition, which results in large discharge-charge voltage gaps (low round-trip efficiency) and poor cycle life [2]. To mitigate the carbon-induced problems of cathodes for Li-O_2 batteries, here, we report a new, carbon-free electrode design based on cobalt oxide. The Co_3O_4-only electrodes are fabricated *via* a combined electrodeposition-conversion process and are applied as a cathode for a non-aqueous Li-O_2 battery. We demonstrate that the cathode architecture (nanosheets, nanoneedles, and nanoflowers) can be successfully engineered by controlling the fabrication parameters. The Li-O_2 battery constructed using the carbon-free Co_3O_4 cathode with the optimized nanoarchitecture shows a remarkably reduced voltage gap (by up to 550 mV compared to the carbon-only cathode) (Fig. 1) as well as excellent long-term cyclability.

Reference

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[2] M. M. Ottakam Thotiyl, S. A. Freunberger, Z. Peng, P. G. Bruce, J. Am. Chem. Soc. 135 (2013) 494.

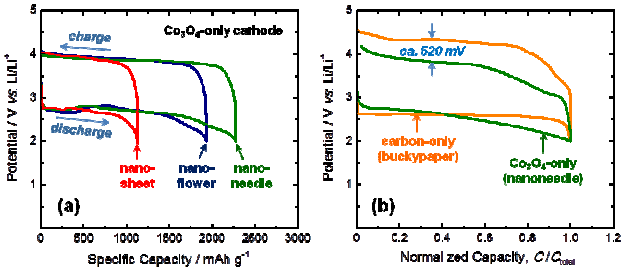

Fig. 1. (a) Discharge-charge profiles of the carbon-free Co_3O_4 cathodes measured at 20 mA g^{-1} in 1 M LiTFSI in TEGDME. (b) Plots of potential *vs.* normalized capacity for the Co_3O_4-only and carbon-only cathodes obtained at 100 mA g^{-1}.