LITHIUM–OXYGEN BATTERIES

Oxide supersedes peroxide

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Under ambient conditions, the mechanism of operation for the oxygen electrode of Li–O_2 batteries is dominated by the reduction of O_2 to lithium peroxide (Li_2O_2) during discharge, and by the oxidation of Li_2O_2 during charge. Unfortunately, Li_2O_2 is insoluble and it can clog the oxygen electrode, which is typically made of porous carbon. Additionally, the ionic and electronic conductivities of Li_2O_2 are low and it is highly reactive towards the organic electrolytes that are typically used in Li–O_2 batteries. These factors all have deleterious effects on the activity of the carbon electrode and the organic electrolyte, and thus the battery cyclability. Now, Linda Nazar and colleagues from the University of Waterloo report a Li–O_2 battery with highly reversible formation of a different discharge product, lithium oxide (Li_2O), avoiding the problems associated with Li_2O_2.

In their battery, the researchers use a Ni-based composite catalyst consisting of lithiated nickel oxides on the surface of Ni nanoparticles (Ni/Li_xNiO_2) at the oxygen electrode, a molten nitrate electrolyte ($LiNO_3$ and KNO_3) that has been previously shown to be chemically stable, and a Li anode protected by a solid-electrolyte membrane. Because oxygen reduction to Li_2O_2 is thermodynamically more favourable than oxygen reduction to Li_2O at ambient conditions, an elevated operating temperature (150 °C) is applied. The researchers show that during discharge Li_2O_2 forms first, but that Ni/Li_xNiO_2, with the aid of the inorganic electrolyte and the elevated temperature, catalyses the breaking of the O–O bond in Li_2O_2, quickly converting it to Li_2O. During charge, direct oxidation of Li_2O takes place without involving the Li_2O_2 intermediate. Stable discharge–charge up to 150 cycles is demonstrated.

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