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Co-Mn Hybrid Oxides Supported on N-Doped Graphene as Efficient Electrocatalysts for Reversible Oxygen Electrodes

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Abstract

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Despite metal-air batteries possessing very high theoretical energy densities, inefficient reversibility of the oxygen reduction reaction (ORR) and the oxygen evolution reaction (OER) at the oxygen electrode undermines their rechargeability, which has slowed their market entry. Herein, we demonstrate a simple procedure for synthesis of a hybrid of MnO and metallic Co supported on N-doped graphene that exhibits activity and stability as a bifunctional ORR/OER catalyst, with a round trip ORR/OER overvoltage of 0.85 V, which remained constant for at least 70 h when cycling alternately, between oxygen evolution at a current density of 10 mA cm^{-2} and oxygen reduction at −1 mA cm^{-2}. Insights into the key properties of the catalyst that influence its performance are proposed based on structural characterization by TEM, SEM, Raman spectroscopy, XRD and XPS. Besides MnO and metallic Co as the predominant crystalline species in the Co-Mn hybrid oxide, XPS revealed Mn_3O_4 and CoO rich surfaces, ascribed to oxidation of MnO and metallic Co due to atmospheric exposure. The synergetic interaction between the Co-Mn hybrid oxides and N-doped graphene, as well as Co-Mn interaction, favor improved ORR, OER and bifunctional ORR/OER performance of the catalyst.