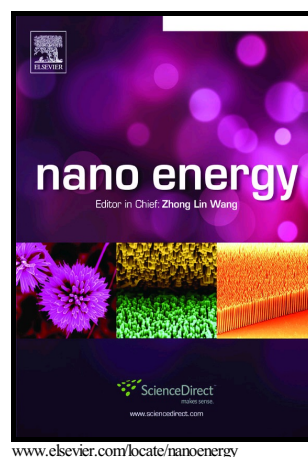


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# Directed synthesis of carbon nanotube arrays based on layered double hydroxides toward highly-efficient bifunctional oxygen electrocatalysis

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## Abstract

The exploration of highly-efficient, low-cost bifunctional oxygen electrocatalysts for both oxygen reduction reaction (ORR) and oxygen evolution reactions (OER) is critical for renewable energy storage and conversion technologies (*e.g.*, fuel cells and metal–air batteries). Here we report the design and fabrication of free-standing nitrogen-doped carbon nanotube (NCNT) arrays *via* a directed growth approach as a high-performance bifunctional oxygen electrocatalyst. By virtue of the unique hierarchical nanoarray structure, uniform N-doping and decreased charge-transfer resistance, the as-prepared NCNT array exhibits rather high activity and stability in both ORR and OER, even superior to the mono-functional commercial Pt/C (for ORR) and IrO<sub>2</sub> (for OER). A flexible, rechargeable all-solid-state zinc–air battery is successfully fabricated by using this self-supporting NCNT electrode as air-cathode, which gives excellent discharge-charge performance and mechanical stability.

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