Facile synthesis of Hollow Fe$_3$O$_4$-Co$_3$O$_4$ Composite for the ORR
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Transition metals incorporated with platinum-base noble metals have been widely investigated as catalysts in fuel cells to enhance the efficiency and lower the amount of precious metals\(^1\). However, the high cost and limited resources hindered the large scale industrial requirements. Transition metal oxide catalysts have been recognized as promising materials to replace Pt-based precious metals for the next generation of fuel cells catalysts.

Traditional synthesis of transition metal oxides including the shell deposition and template removing procedure, which is tedious and time consuming. Herein, we prepared the hollow structured transition metal oxide composite which is supported on carbon nanotube via an impregnation-reduction-oxidation method. The hollowed structure forms as the results of Kirkendall effect during oxidizing. Moreover, no template or surfactants are needed in the whole experiment. An initial structure characterization, as well as the electrocatalytic activity for the oxygen reduction reaction (ORR) was conducted. The good performance was obtained on the Fe$_3$O$_4$-Co$_3$O$_4$ material. As shown in Fig.1, the as-prepared composite has good crystal structure and excellent ORR activity, although a little lower than commercial Pt/C.

Fig.1 The synthesis procedure of Fe$_3$O$_4$-Co$_3$O$_4$ composite and its physical and electrochemical characterization.