

Mesoporous Niobium-Doped TiO₂ Support for Oxygen Evolution Catalyst in SPE Water Electrolyzer

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Hydrogen is well accepted as an important energy carrier with higher energy density and no harmful emissions. However, hydrogen is not an energy source and must be produced with other energy. Water splitting with renewable energy provides a most clean access for hydrogen production.

¹SPE water electrolyzer (SPEWE) has been proven as an efficient solution to convert nowadays' great proportion of excess power generated by renewable energy such as wind and photovoltaic power. IrO₂ is widely employed as the oxygen evolution catalyst in SPE electrolyzer due to its high electrochemical activity as well as its stability in strong acid under high anode potential. Unfortunately, the scarcity of global iridium reserves obstructs SPEWE from expanding application. Dispersion with support has been introduced to Ir-base catalyst by researchers. ^{2, 3} Modification of electric features by doping has made corrosion-resistant titania

adequate for a support of catalysts in proton exchange membrane fuel cell (PEMFC). In this work, niobium-doped TiO₂ with varied doping amount was prepared by evaporation-induced self-assembly (EISA) and then composited with IrO₂ by Adams fusion method. Unsupported IrO₂ was synthesized in the same process. Electrochemical characterizations of these samples were carry out in order to figure out their influence on oxygen evolution reaction (OER) catalyst.

XRD patterns of IrO₂/[Ti_{100-x}Nb_x]₁O₂ composite catalysts (x = 5, 10) show that IrO₂ particles has been synthesized at a nanometer scale. The [Ti₉₅Nb₅]₁O₂ contained two phases as the anatase and rutile, while [Ti₉₅Nb₅]₁O₂ maintained a single-phase anatase structure after the IrO₂ synthesis, indicating strong stability under high temperature and extreme oxidizing atmosphere. Fig 1 gives cyclic and linear sweep voltammetry curves of 40wt% IrO₂/[Ti_{100-x}Nb_x]₁O₂ (x = 5, 10) as well as unsupported IrO₂ prepared in same process. Composite catalysts performed a higher capacitance brought by the doped titanium supports, and comparable activity of oxygen evolution reaction. The ohmic resistance of the supports caused additional overpotentials comparing with unsupported IrO₂, while there was some performance improvement with the increase of doping amount. The stability of supported catalysts was found to be well gratifying, testified by tiny degradation after 1000 cycles as shown in Fig 2. This indicates niobium-doped TiO₂ as a promising oxygen evolution catalyst support with further optimization on doping amount, morphology and the phase structure.

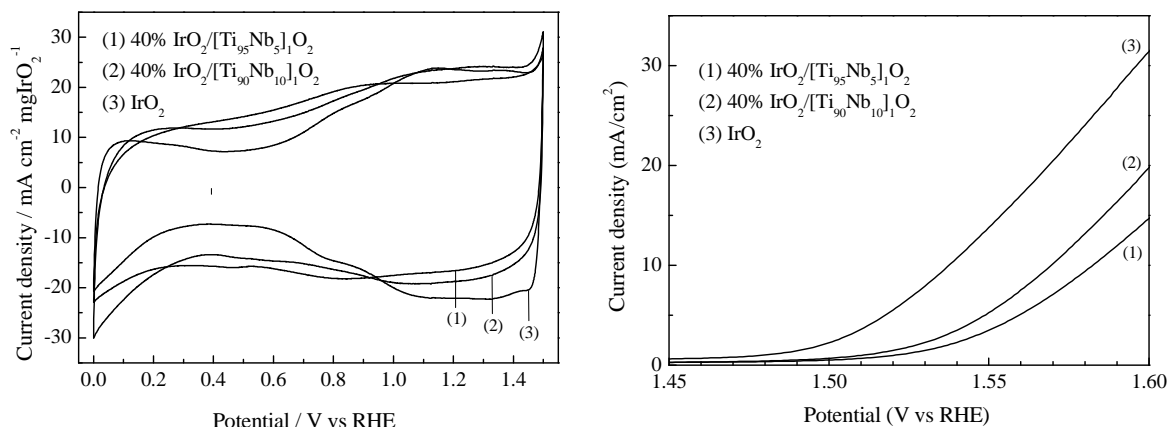


Figure 1: Cyclic (left) and linear sweep voltammetry (right) of 40wt% IrO₂/[Ti_{100-x}Nb_x]₁O₂ (x = 5, 10) and unsupported IrO₂ in N₂-saturated 0.1M HClO₄ solution. Sweep rates are 50 mV s⁻¹ and 5 mV s⁻¹ respectively.

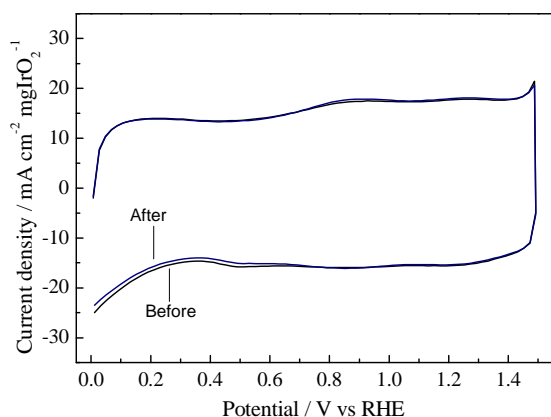


Fig 2 Cyclic voltammetry of 40wt% IrO₂/[Ti₉₅Nb₅]₁O₂ before and after 1000 cycles.

References

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