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Low Iridium Deposition on Dendritic Gold for Enhanced Oxygen Evolution in Water Splitting

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Extended Abstract

Dendritic gold nanoparticles were first synthesized on carbon fiber paper, followed by the formation of gold–iridium electrodes via underpotential deposition and subsequent galvanic replacement of a copper monolayer with iridium[1]. By varying the number of copper deposition/iridium replacement cycles (Ir_n@Au, n = 1, 2, 3, 4), the catalytic performance of the resulting electrodes was systematically evaluated in both acidic and alkaline media.

Characterization by scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS) confirmed the successful surface modification of iridium on the dendritic gold structure[2]. Electrochemical measurements, including cyclic voltammetry (CV) and linear sweep voltammetry (LSV), revealed that the gold–iridium electrodes possessed a high electrochemically active surface area (ECSA) of up to 56.0 cm^2, indicating a large number of accessible active sites for catalytic reactions.

Under alkaline conditions, the Ir_3@Au electrode achieved an overpotential of only 290 mV (vs. RHE) with a Tafel slope of 49 mV/dec, while under acidic conditions, it exhibited an overpotential of 320 mV (vs. RHE) and a Tafel slope of 87 mV/dec, demonstrating excellent catalytic activity toward the oxygen evolution reaction (OER). The incorporation of iridium significantly enhanced OER activity across both pH environments, reducing overpotentials and Tafel slopes compared to unmodified electrodes.Stability tests via chronoamperometry showed minimal degradation: 7.27% after 5000 seconds at constant current in alkaline electrolyte and only 2.70% in acidic electrolyte, underscoring the electrode's excellent operational durability.

Notably, the turnover frequency (TOF) of Ir_1@Au reached 1.80 s^{-1} at an overpotential of 300 mV in acidic media, indicating high atomic utilization efficiency[3]. These results suggest that the synergistic interaction between iridium and dendritic gold effectively tunes the catalyst's electronic structure, enhances reactant adsorption, and boosts catalytic performance, highlighting its strong potential for practical water splitting applications.

References

[1] F.-H. Cho, M.-H. Huang, Y.-M. Chen, Y.-B. Huang, C.-J. Su, U. S. Jeng, Y.-H. Lai, *Applied Surface Science* **2019**, *485*, 476-483.
[2] Y.-H. Lai, S.-R. Li, H.-T. Chang, Y.-B. Huang, Y.-K. Li, Y.-M. Chen, S. B. Patil, S.-Y. Chang, P.-K. Chen, C.-C. Chang, *Journal of Materials Chemistry A* **2021**, *9*, 22901-22912.
[3] C. Wang, A. Schechter, L. Feng, *Nano Research Energy* **2023**, *2*, e9120056.