

Oxygen Evolution/Water Oxidation at TiO₂ Powder and Nanotube Electrodes †

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Abstract: The photodeposition (under UVA light) of Ir/IrO₂ nanoparticles on particulate TiO₂ (Degussa, P-25[®]) and electrochemically formed self-organized TiO₂ nanotubes (TNTs) is reported. The effect of sacrificial reagent concentration (MeOH; commonly used in metal photodeposition) and deposition duration (2, 5, and 8 h) on the amount of noble metal in the catalysts has been investigated. The absence of methanol and maximum photodeposition time leads to an increased amount of noble metal/metal oxide; the unexpected adverse effect of methanol is indirect evidence that this occurs at the valence band of the illuminated TiO₂ semiconductor, where photogenerated h⁺ and/or OH[•] oxidize Ir(III) to Ir(IV). The surface electrochemistry of IrO₂/TiO₂ in 0.1 M HClO₄ solutions exhibits similar features to those of anodically formed IrO₂. The electrocatalytic activity of IrO₂/TiO₂ towards the Oxygen Evolution Reaction (OER) in 0.1 M HClO₄ solutions showed that catalysts synthesized in the absence of MeOH possess the highest catalytic activity, with current densities in the range of those reported for commercially available unsupported IrO₂ nanoparticles. IrO₂/TNT catalysts have also been tested. Limited IrO₂ deposition on the outer surface of semiconducting TNTs (hence limited conductivity in the dark) meant that only under UVA illumination IrO₂ become electrochemically active.

Keywords: electrocatalysis; oxygen evolution; titanium dioxide; iridium oxide; photodeposition.

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Conflicts of Interest

The authors declare no conflict of interest.