

New DSPEC Photoanode Designs

Scientific Achievement

- Unbiased water splitting cell with molecular chromophores and catalysts combining mesoporous $\text{SnO}_2/\text{TiO}_2$ and a silicon p-n junction.
- Tandem system with dye-sensitized photoelectrochemical cell (DSPEC) wired in series with dye-sensitized solar cell (DSC) demonstrated light-driven production of H_2 from water with no applied electrical bias.

Significance and Impact

- Combination of molecular chromophore-catalysts with conventional silicon represents new paradigm for design of tandem water-splitting cells.
- First use of a dye-sensitized photoanode based tandem photoelectrochemical cell that uses only energy from solar illumination to convert water to O_2 and H_2 .

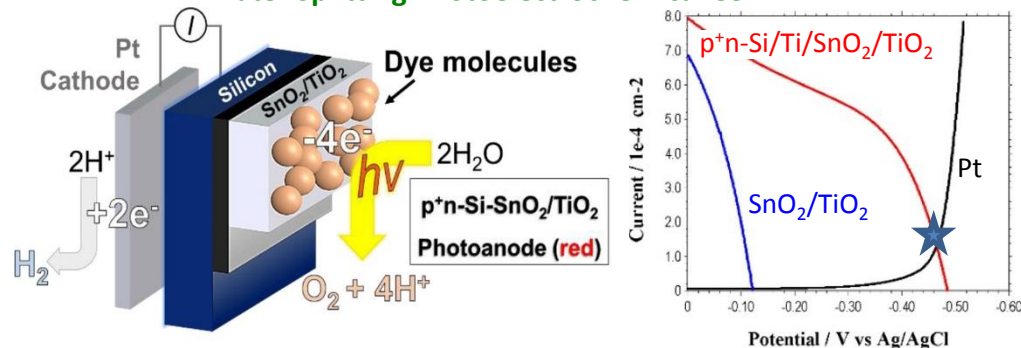
Research Details

- Mesoporous $\text{SnO}_2/\text{TiO}_2$ films derivatized with Ru-based chromophores and water oxidation catalysts. Silicon p⁺-n wafers provide additional photo-potential needed for water splitting.
- DSPEC** photoanode, incorporating Ru-based chromophores and catalysts, tested in tandem configurations with red-absorbing DSCs:
 - N719 dye with I_3^-/I^- redox mediator solution (**N1**).
 - D35 dye with $[\text{Co}(\text{bpy})_3]^{3+/2+}$ -based mediator (**D1**). Best performance demonstrating H_2 production from H_2O with energy input only from simulated solar illumination.

Work was performed at UNC Chapel Hill.

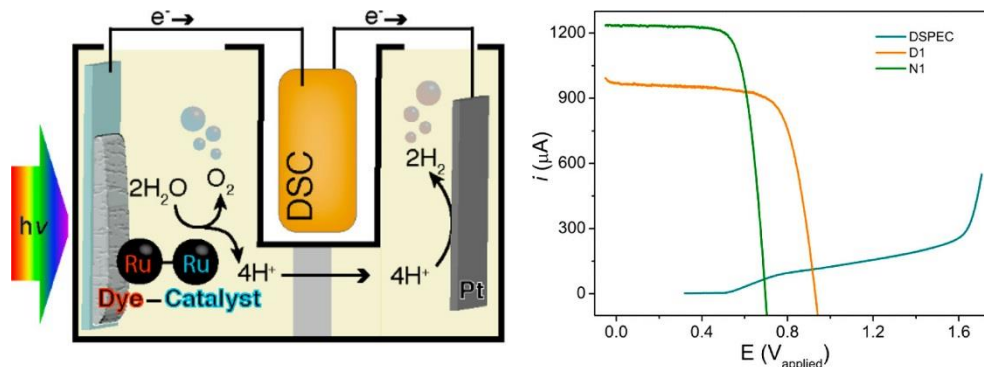
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A. All-in-One Derivatized Tandem p⁺n-Silicon-SnO₂/TiO₂ Water Splitting Photoelectrochemical Cell



Linear scan voltammograms of p⁺n-Si-Ti/ $\text{SnO}_2/\text{TiO}_2$ -2RuP²⁺/1 under 1-sun illumination (red), FTO- $\text{SnO}_2/\text{TiO}_2$ -2RuP²⁺/1 (blue), and a Pt electrode (absolute current, black), where 1 is water oxidation catalyst $[\text{Ru}(\text{bda})(4\text{-O}(\text{CH}_2)_3\text{PO}_3\text{H}_2)\text{-pyr}]_2$

B. Dye-Sensitized Photoelectrochemical Tandem Cell for Light-Driven Hydrogen Production from Water



Current vs applied voltage for **DSPEC** (blue), and **DSC D1** (orange) and **N1** (green), under illumination with 100 mW cm^{-2} white light