Imperial College London

Photoelectrochemical H_2 Production Using Solar Energy

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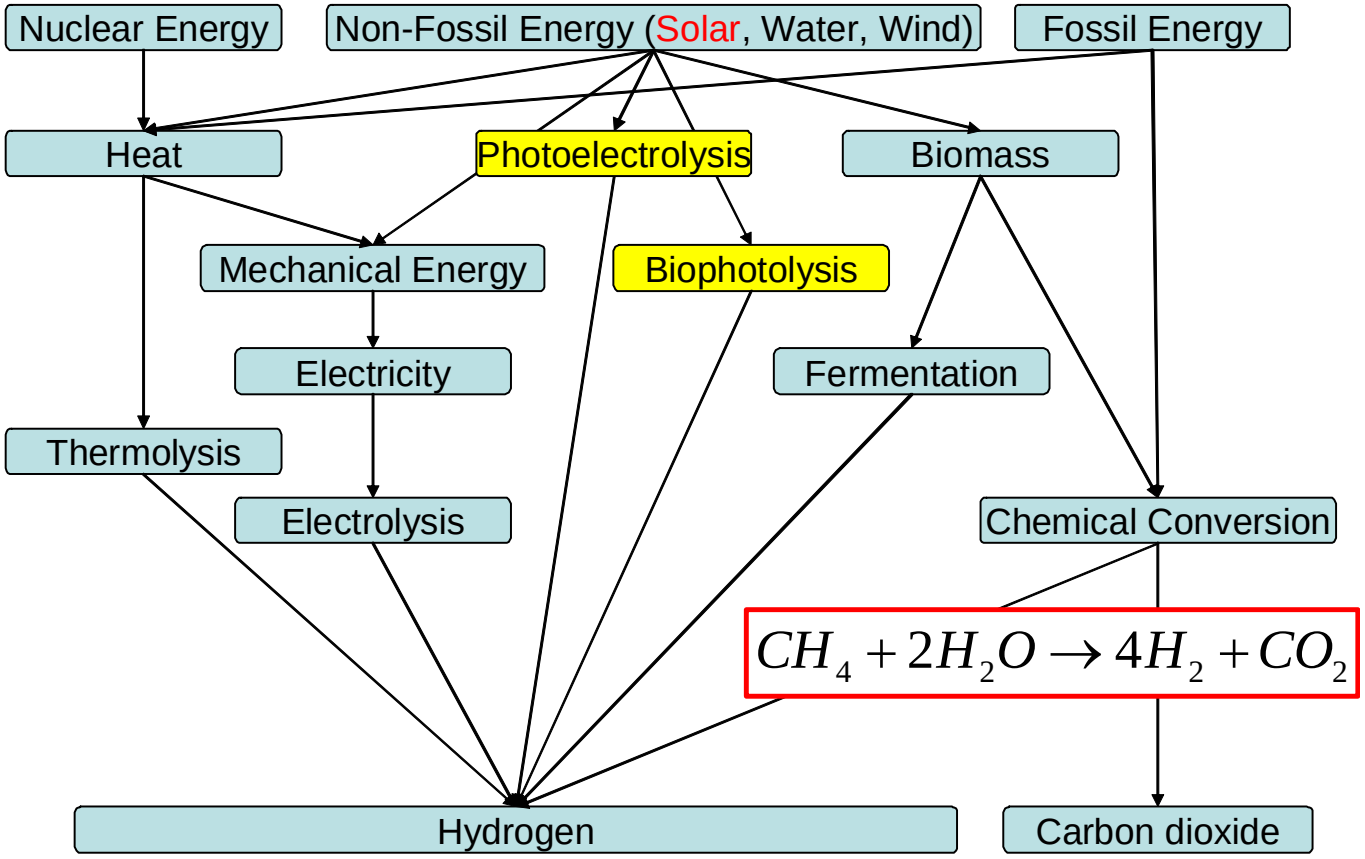
Routes to Hydrogen Production

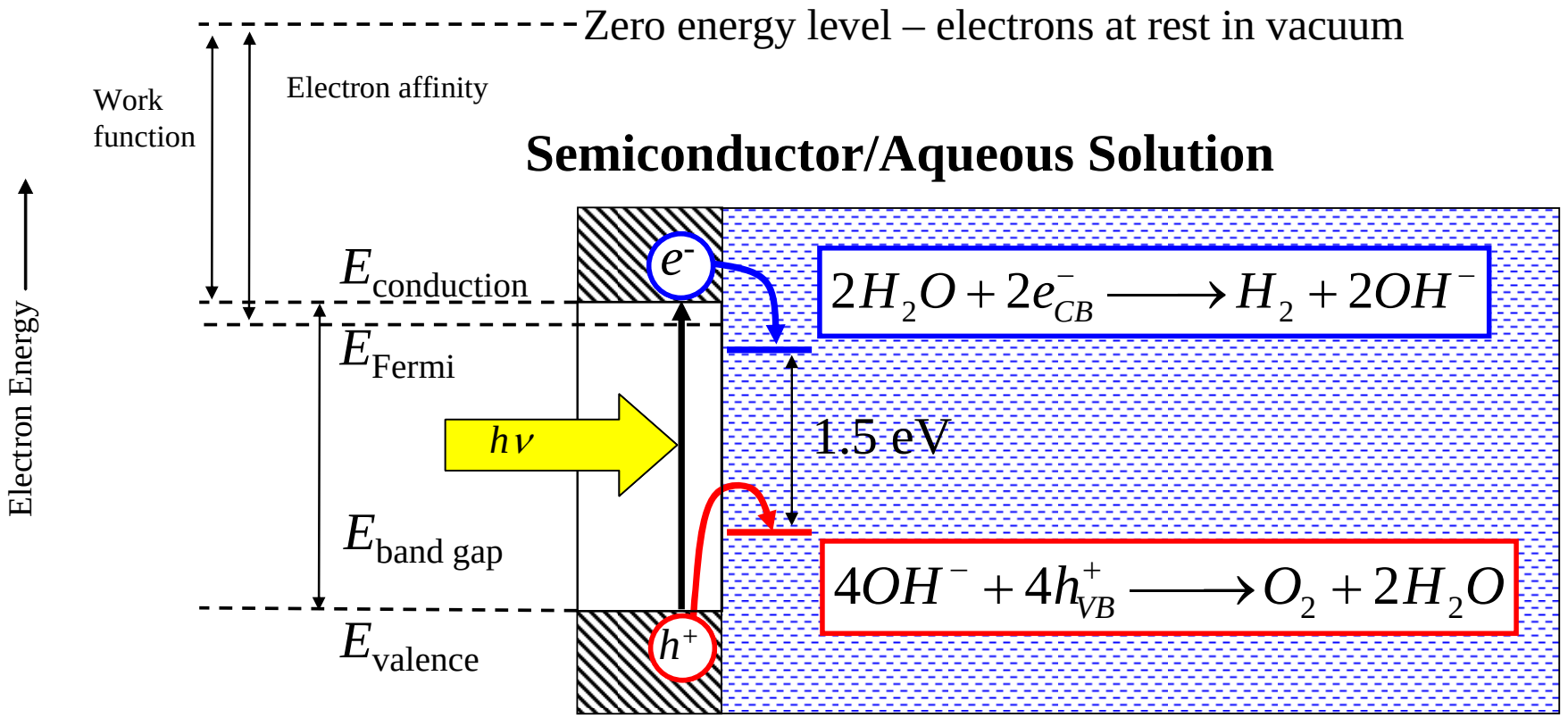


adapted from J.A.Turner, Science 285, 687(1999)

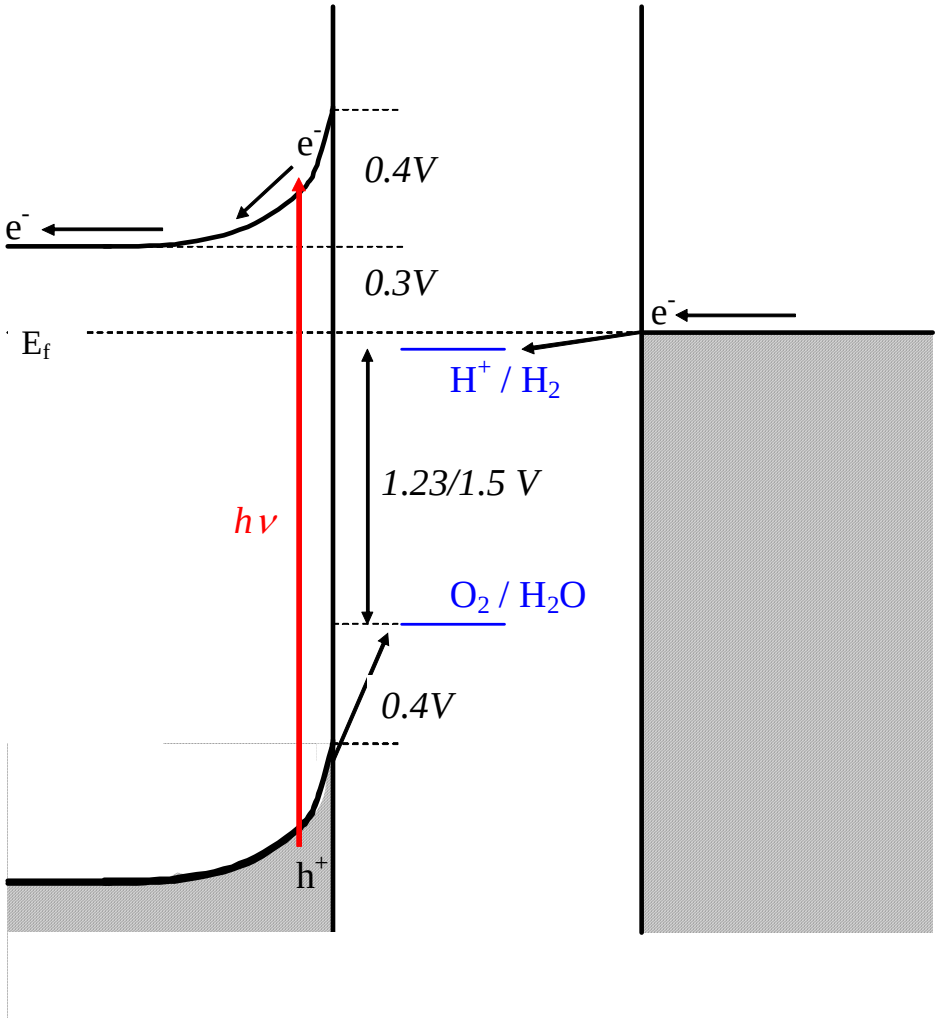
Solar Energy to Hydrogen Project at Imperial

- Development of alternative *cost effective* methods to produce renewable H_2, using low temperature photo-biological and/or photocatalytic processes.
- To link this into novel, integrated energy production systems, closely coupling advances in science and engineering.
- The work meets the strategic vision of Imperial College, and brings together the Faculties of Natural Science and Engineering under the umbrella of the Energy Futures Lab.
- £4.2M grant awarded by EPSRC (started in October 2007)

Energetics at the Semiconductor-Electrolyte Interface



Energy Requirement for Photoelectrolysis



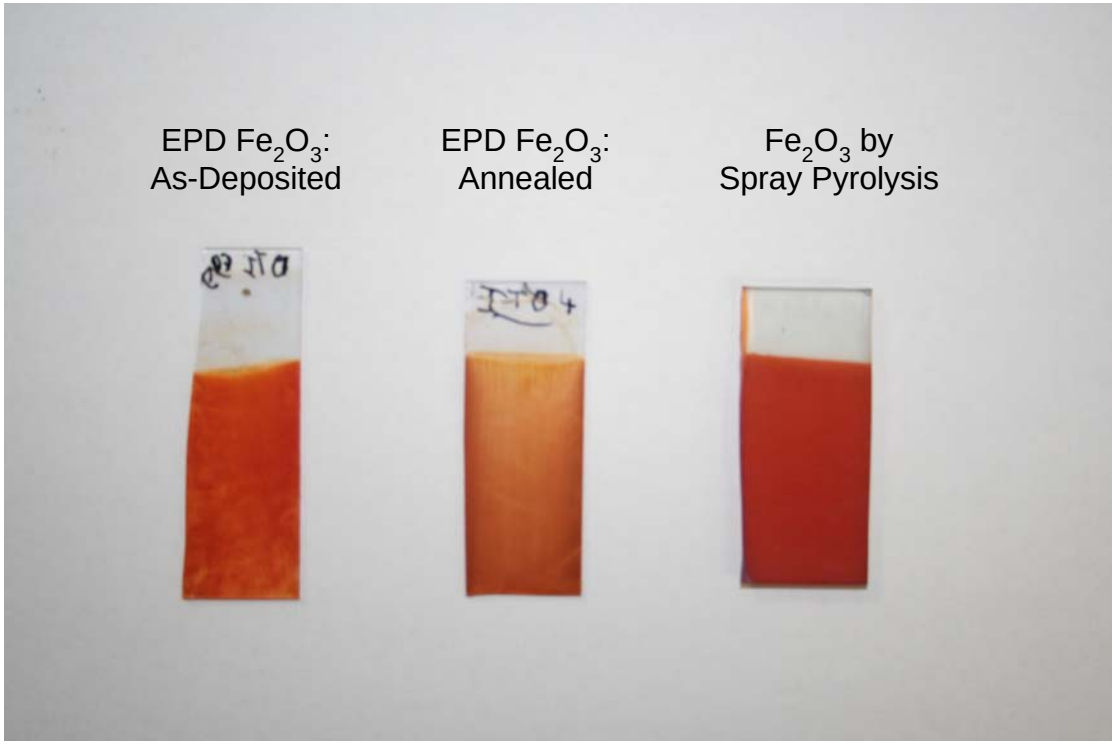
Candidate Materials

- WO_3: E_g ~ 2.6 eV
- Fe_2O_3: E_g ~ 2.2 eV.
  - synthesised simply(?) by a variety of methods
  - low-cost
  - good starting point - follow-on from work at Hydrogen Solar

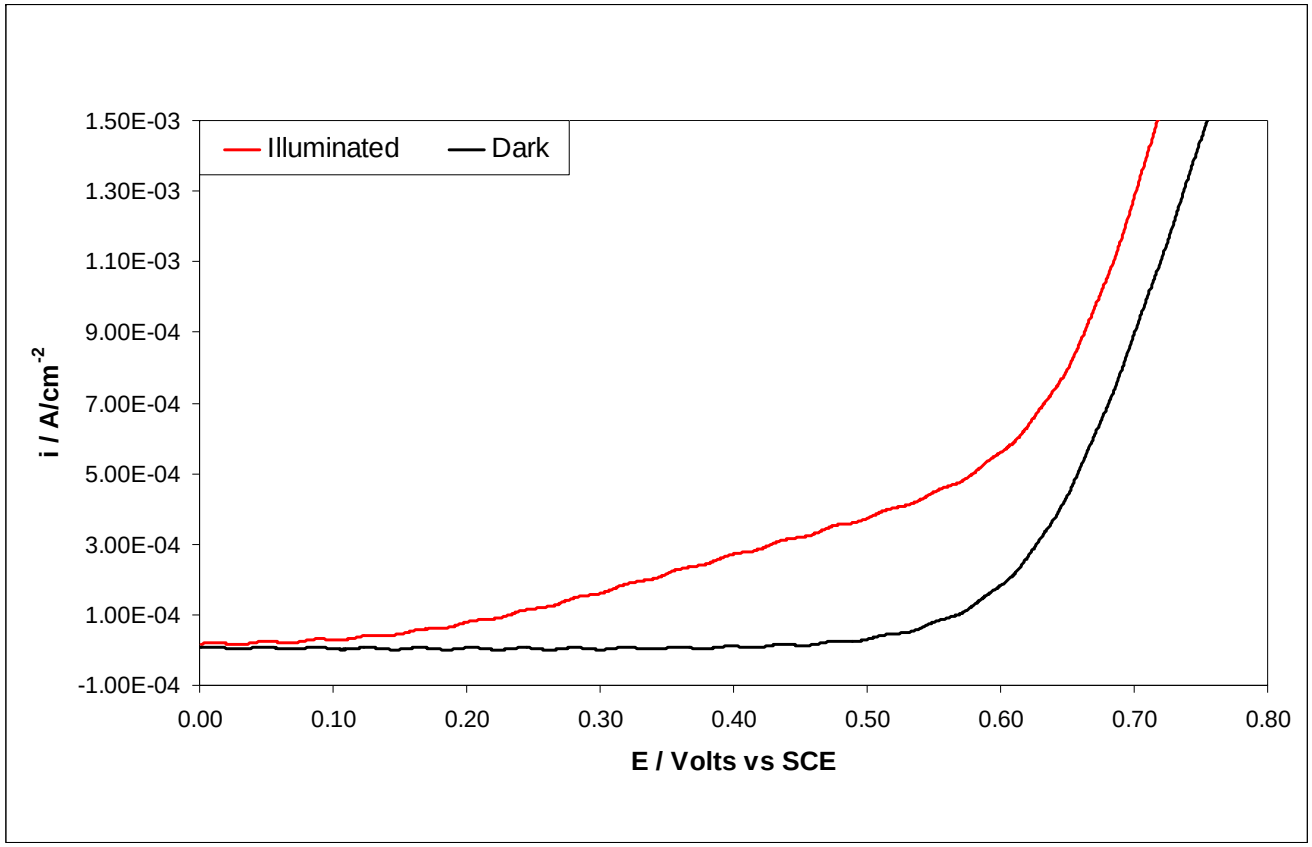
Fe_2O_3 Nanoparticle Preparation

- Hydrothermal:
  - Fe^{2+}/urea-glycine/100°C $\longrightarrow$ Fe_2O_3/Fe_3O_4
- Precipitation:
  - Fe^{2+}/95°C $\longrightarrow$ Fe_2O_3
- Anodisation:
  - Fe electrode in glycerol + mineral acid: no anodic films

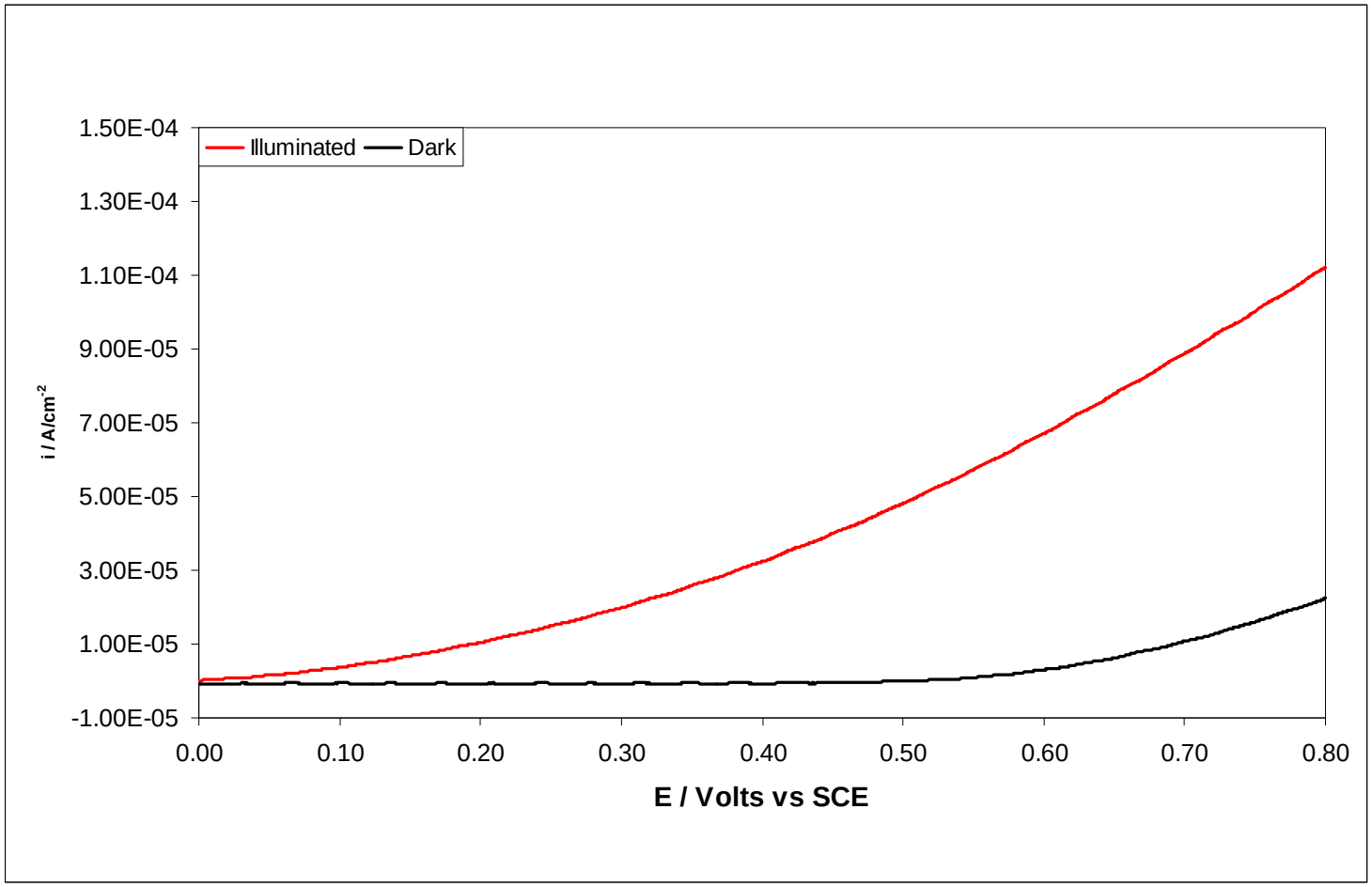
Fe_2O_3 Photoelectrodes



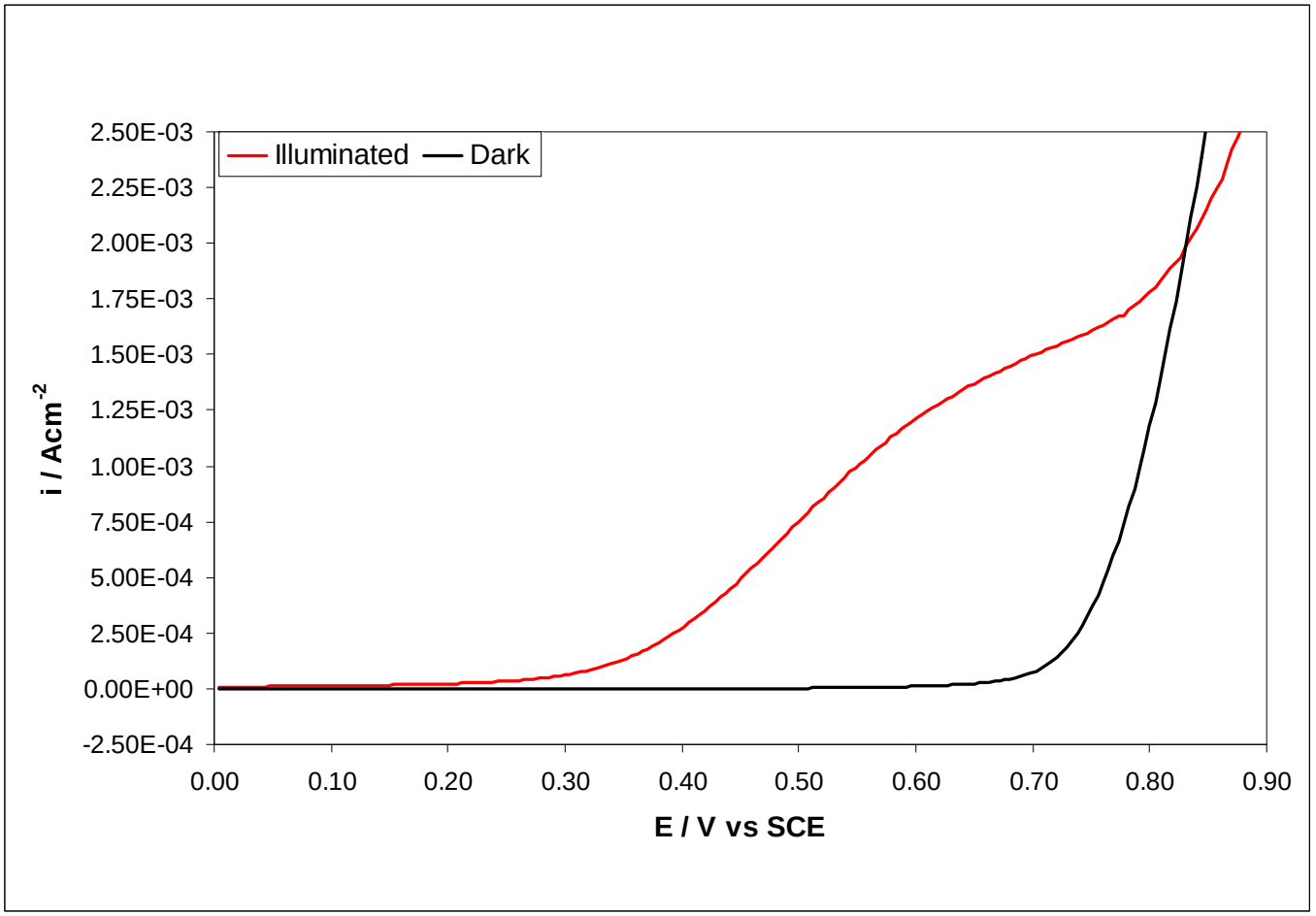
As-Deposited EPD-Fe_2O_3



Annealed EPD-Fe_2O_3



Fe_2O_3 by Spray Pyrolysis



Photoelectrode Performance

	Dip Coated	Electrophoretic Deposition	Spray Pyrolysis *
	/ Acm^{-2}	/ Acm^{-2}	/ Acm^{-2}
As-deposited	3×10^{-6}	6×10^{-4}	1.22×10^{-3}
Annealed ‡	1×10^{-6}	7×10^{-5}	-

* Produced at Hydrogen Solar: $FeCl_3/SnCl_2$ (1%) in EtOH
‡ 400°C in air for 30 min.

Future Work

- Materials development:
  - Improvements to Fe_2O_3 and other fabrication techniques
  - New materials: e.g. N-doped TiO_2.
- Photoelectrochemical reactor design
- Leading, ultimately, to a demonstrator system

Acknowledgements

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