Universität Basel

Dye- sensitized Solar Cell

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Outline

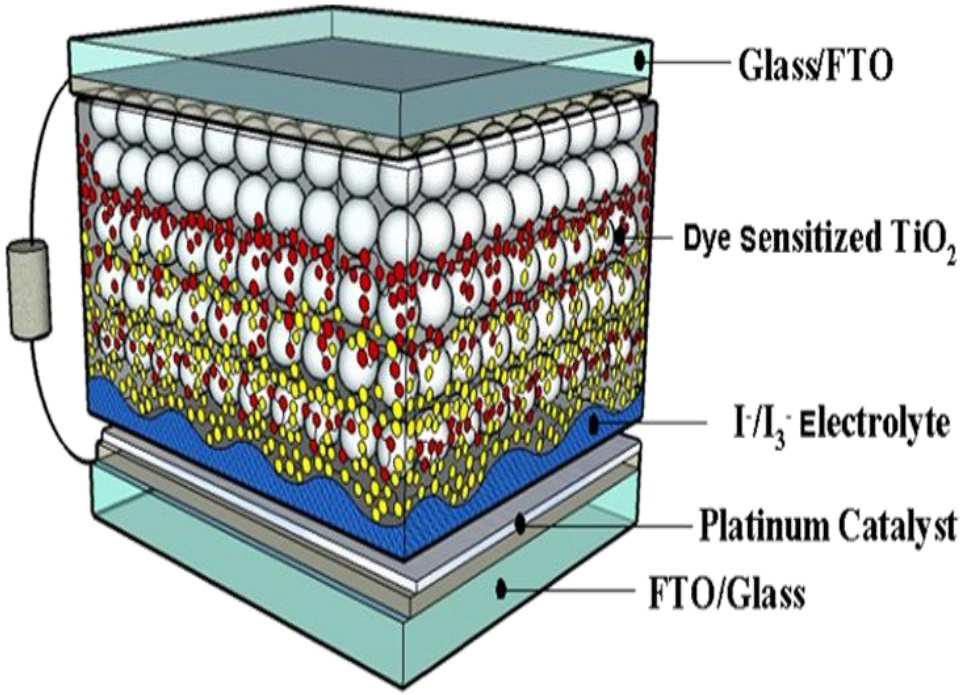
1. Introduction
2. The Construction of Dssc
3. The Mechanisum of Dssc
4. Key Efficiency parameters of Dssc
5. Advantages/ disadvantages
6. Pressent Dssc research and development

Introduction:

- 1960 (discover)
- 1972 (the demonstration and discussion)
- 1988 (Invetation by Brain O Regan and Micheal Grätzel)
- 1991 (the first efficiency)
- 2010 (prize)

The Construction of DSSc

- Fluoride- doped tin- dioxide (SnO_2:F)
- titanium oxide (TiO2)
- photosesitive (ruthenium-polypyridine dye)
- iodide electrolyte
- platinum metal



The mechanisum of DSSc:

- **Reaction 1 and 2**: electron injection and excited state decay

$$S + h\nu \rightarrow S^* \text{ (photoexcitation)}$$

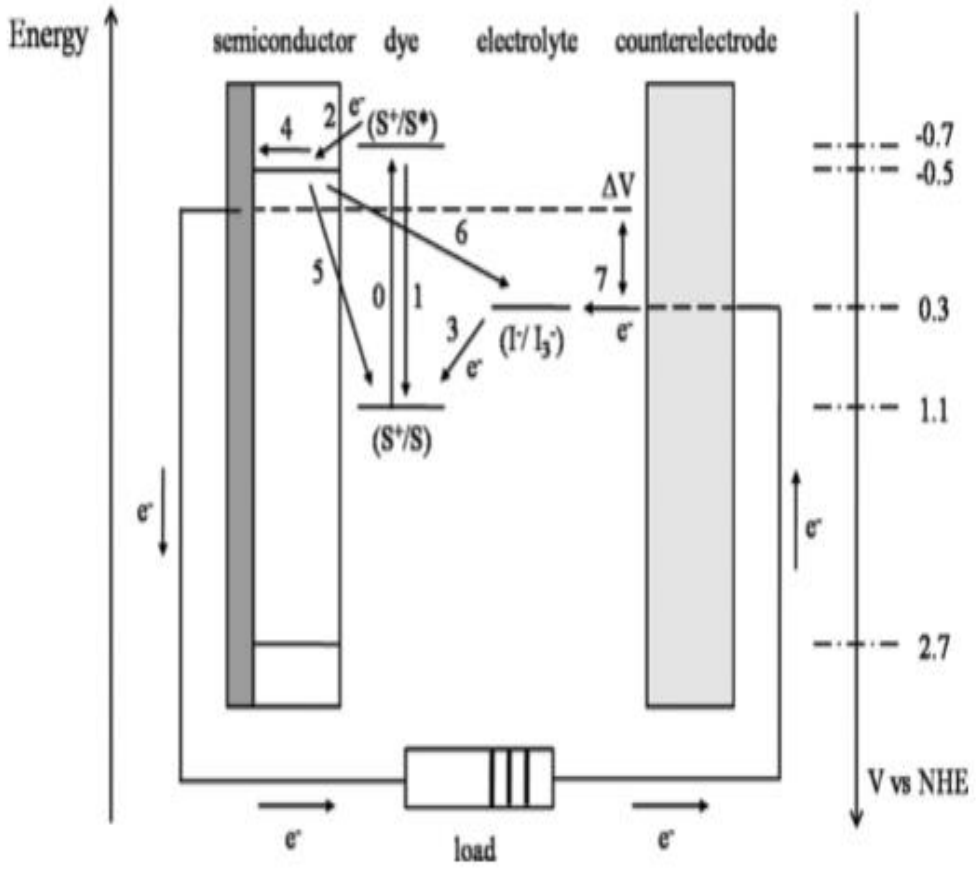
$$S^* \rightarrow S + h\nu' \text{ (emission)}$$

$$S^* \rightarrow S^+ + \text{e-cb (Ti}O_2\text{ Charge injection)}$$

- **Reaction 3**: Regeneration of the oxidized dyes

$$2S^+ + 3\,I^- \rightarrow 2S + I_3^- \text{ (regeneration of S)}$$

- **Reaction 4:** electron transport through the mesoporous oxide film

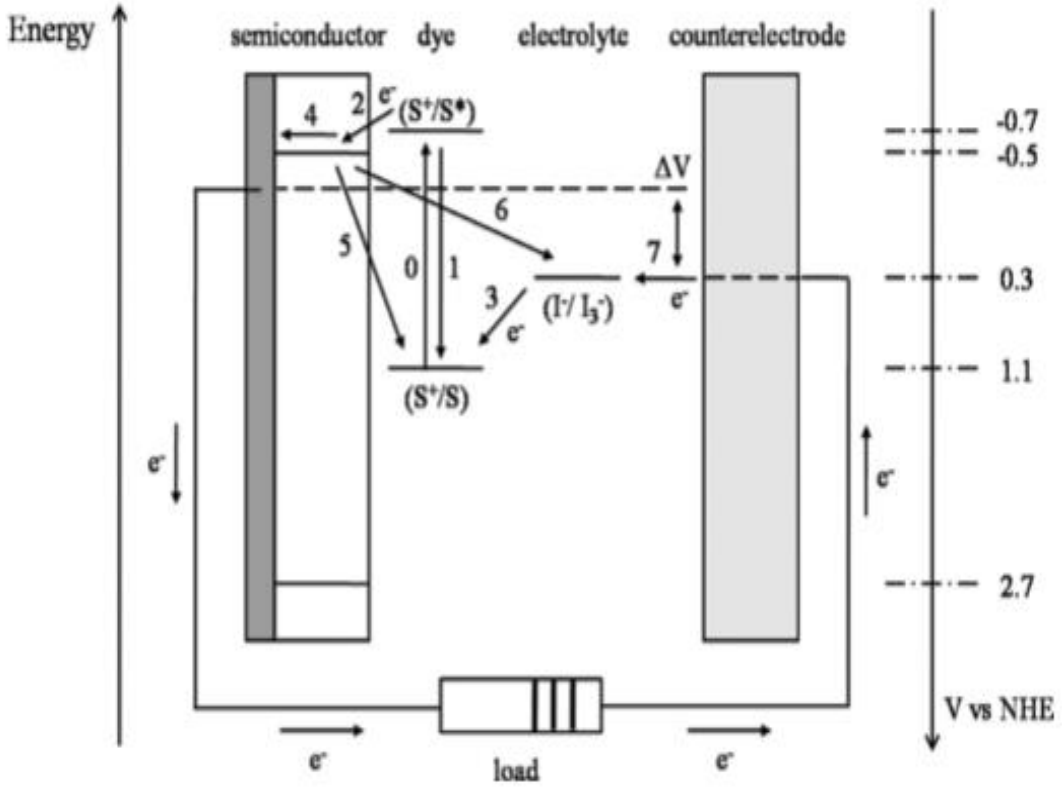


- **Recation 5 and 6** : recombination of electrons in the semiconductor with oxidized dyes or electrolyte speicies

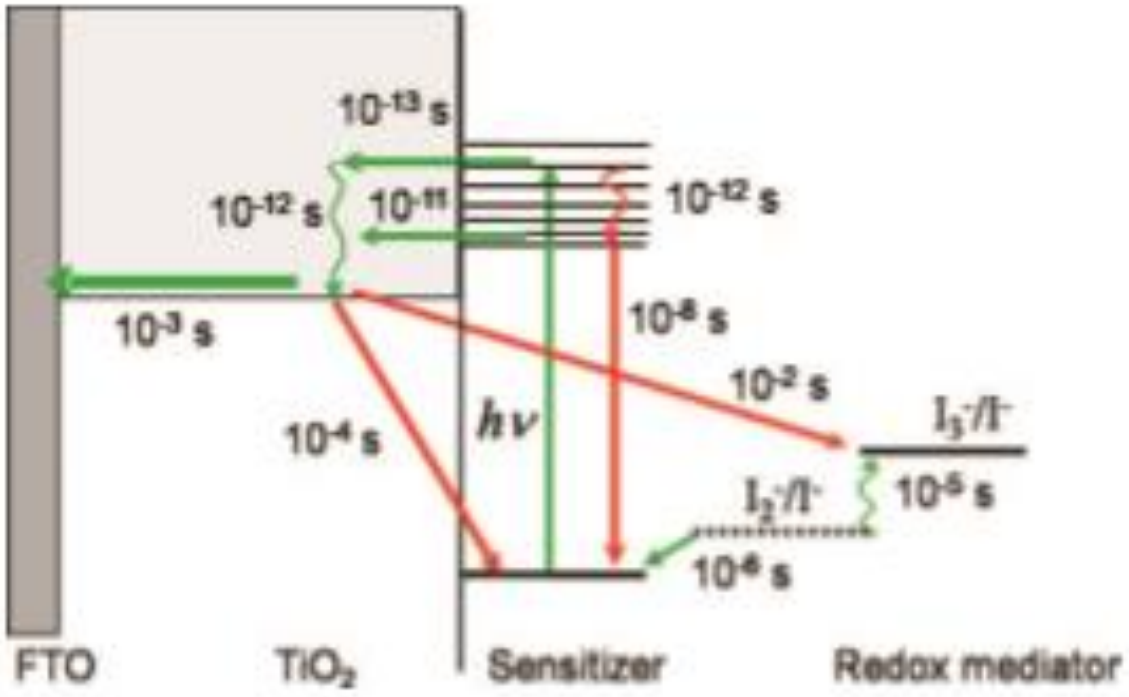
$S^+ + e^-$ (TiO_2) $\rightarrow S$ (recombination)

- **Reaction 7:** reduction of electron acceptors in the electrolyte at the counter electrode

$I_3^- + 2e^- \rightarrow 3I^-$ (regeneration of I^-)



The process of electron transfer taking place at the oxide/dye/electrolyte interface



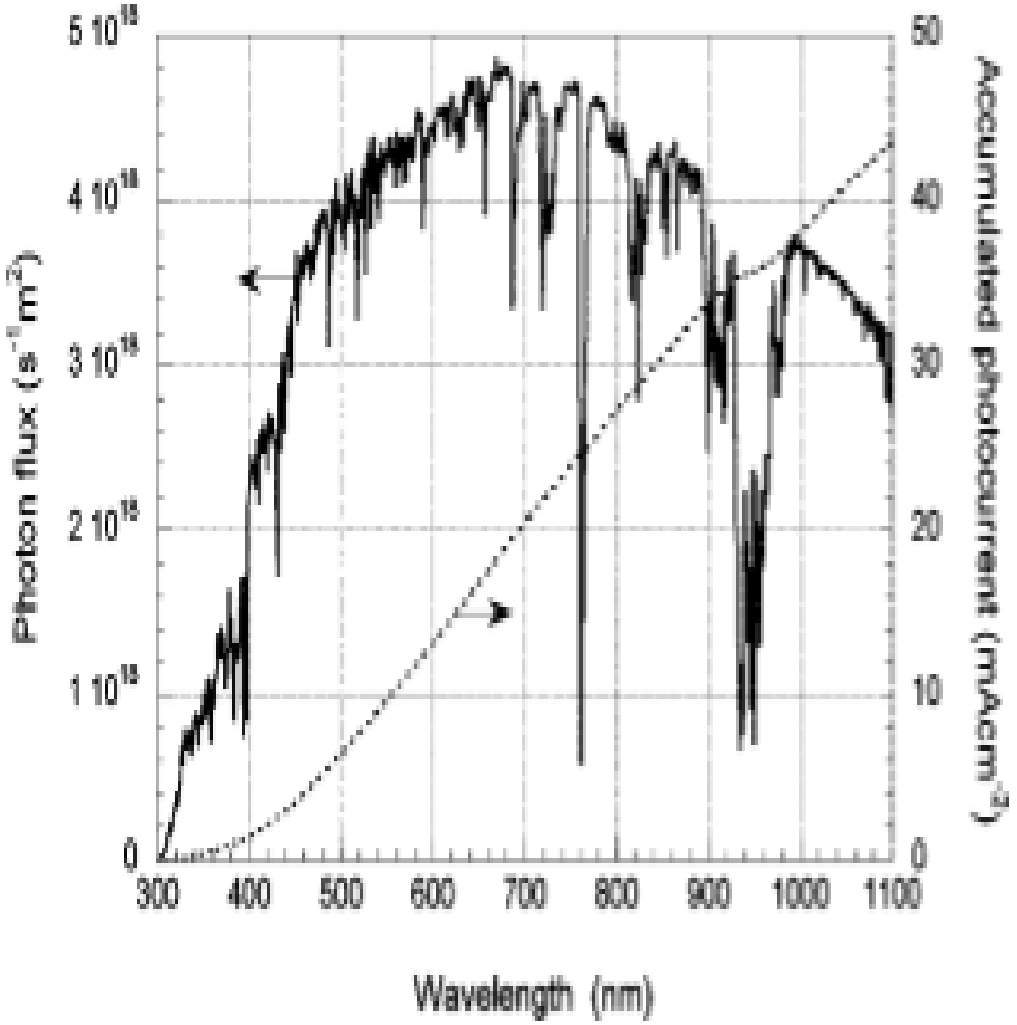
Key efficiency parameters of a DSSc :

- Air mass (AM) = 1/COSφ

φ : is the angel of elevation of the sun

- The standard solar spectrum (solar cells) :

AM 1.5 G (global) , φ =42



The irradiance of the sun as a function of wavelenght

Key efficiency parameters of a DSSc :

η : electrical energy conversion efficiency

$$\eta = \frac{P_{max}}{P_{in}} = \frac{I_{SC} \cdot V_{OC} \cdot FF}{P_{in}}$$

J_{sc}: short circut current

V_{oc} : open circut photovoltage

FF: filling factor

P_{in} : the intencity of the incident light

the filling fctor can assume values

between 0 and less than 1

FF=$P_{max}/J_{SC}\,V_{OC}$

IPCE = $\frac{J_{SC}(\lambda)}{e\phi(\lambda)}$

(incident photon to current conversion efficiency)

e: elementary charge

$\emptyset$: incident ratiative flux (W/m^2)

Advantages/disadvantags

Advantages :

- Lightweight
- flexibility
- Some selling points

Disadvantag :

- Liquid electrolyte
- Cost
- Electrolyte solution

Pressent DSSc research and development

Researchers at Ecole Polytechnique Federale de Lausanne:

- New melocules (electrolyte)/liquid or gel
- At the cathode platinum → cobalt sulfide

last 5-10 years :

- liquid electrlyte → solid hole conducting material (hybrid perovskite dye)
- Solid state DSScS with 15% efficiency

References:

- Fundemental Sciences:

Dye- Sensitized solar celles (Edited by K.Kalyanasundaram)

- Materials concepts for solar cells:

Thomas Dittrich

- Dye sensitized solar cells:

Anders Hagfeld, Gerrit Boschloo, Licheng Sun, Lars Kloo,

Henrik Pettersson

Thank you