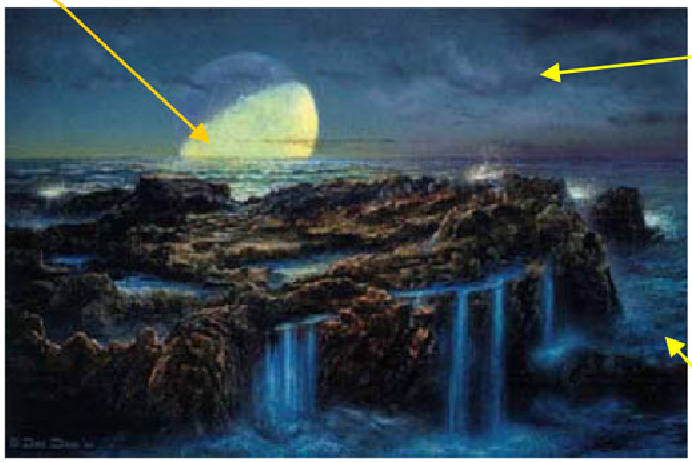
Energia solar e hidrogênio: fotoeletroquímica. Processos eletrostáticos.

Leitura: Nina Hall, Neoquímica, Bookman (2004), capítulo 15

Fotoeletroquímica

Four Billion Years Ago...

UV radiation ($\lambda < 150$nm):
1.6×10^{-9} einsteins•cm^{-2}•sec^{-1}



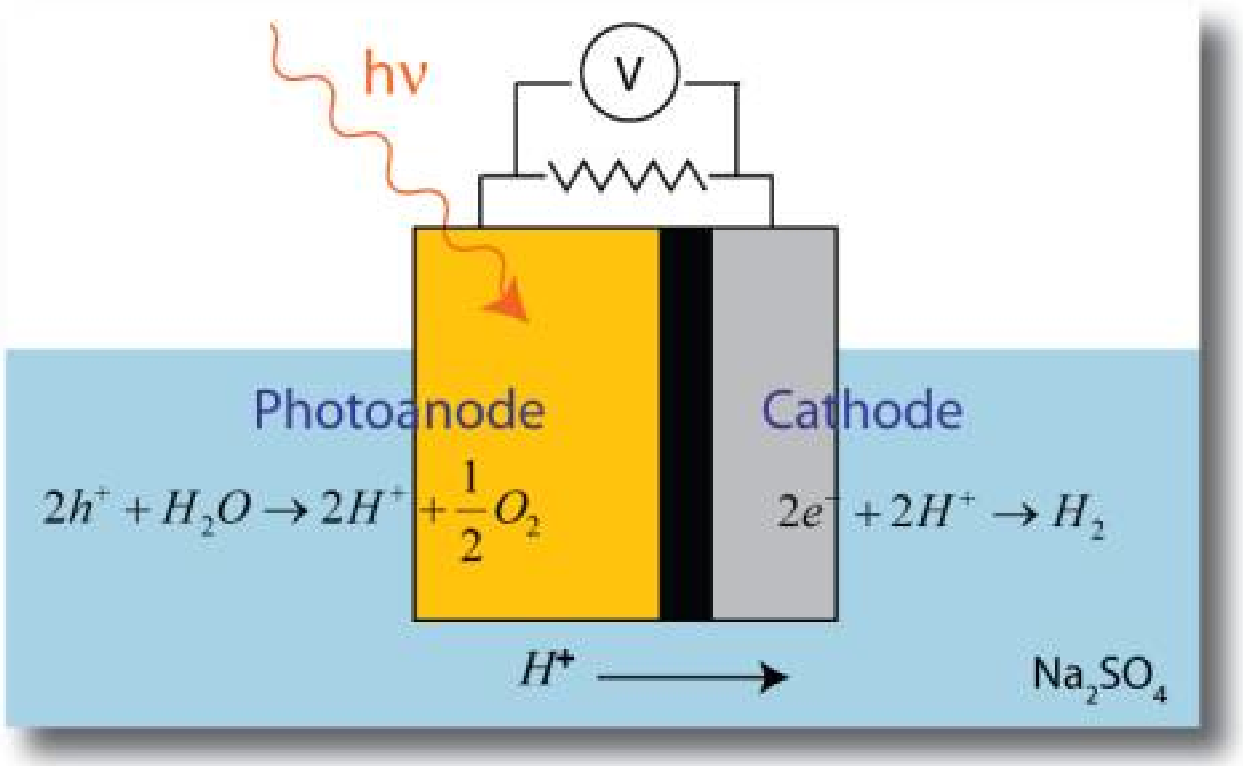
Early Atmosphere:
CO_2: 1 to 10 atm
N_2, CO,
H_2S: 10^{-4} atm
CH_4: 10^{-4} atm
O_2: No

How did life begin?

Early Ocean:
Na^+, Mg^{2+}, Cl^-, SiO_3^{2-}, HCO_3^-,
pH = 5.5, T > 50 °C

http://www.seas.harvard.edu/environmental-chemistry/projects/four_billion.jpg

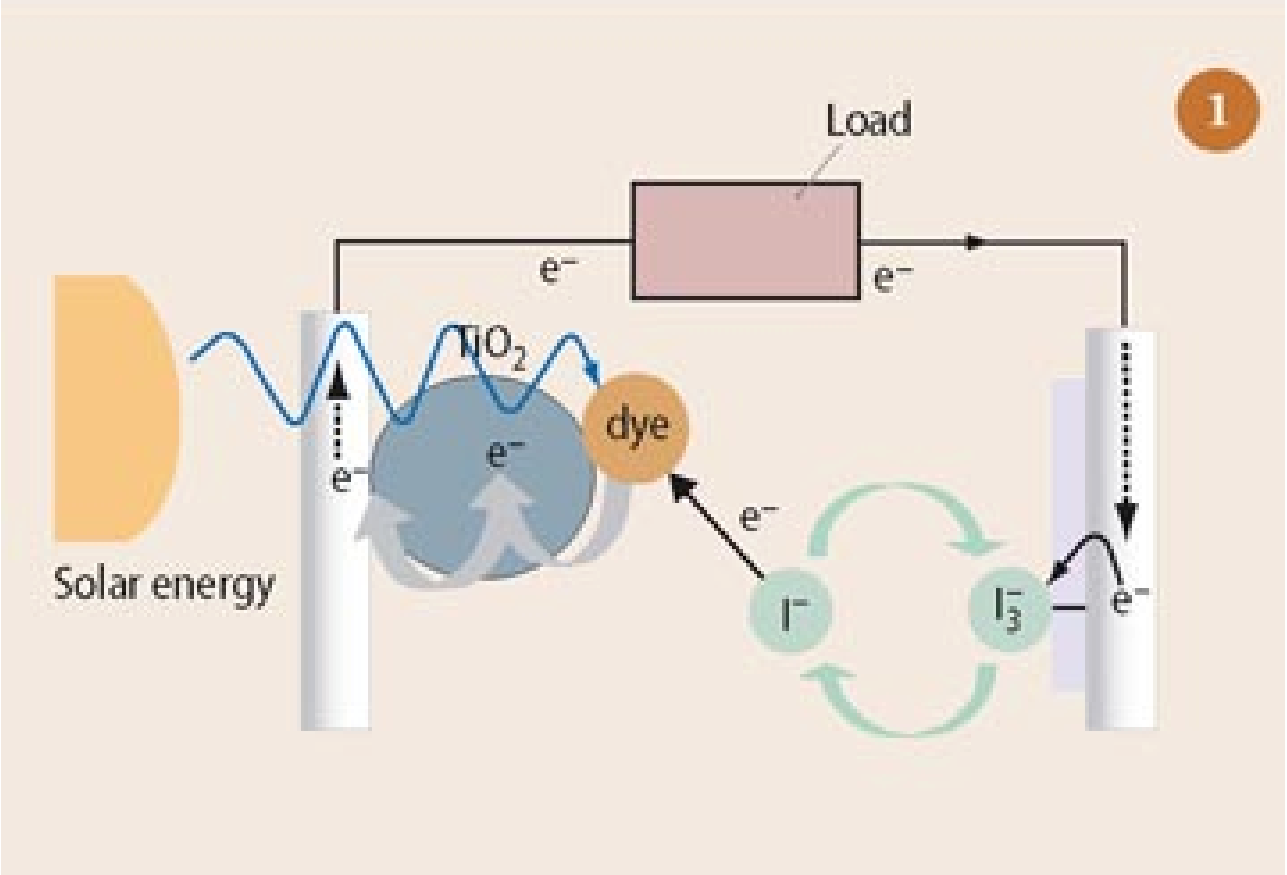
Fotoanodos de semicondutores



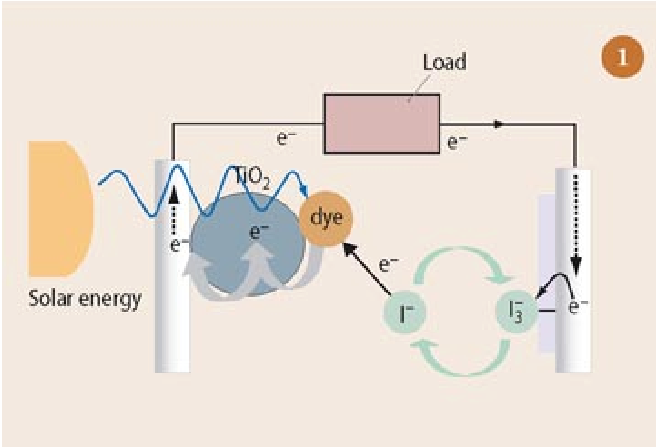
Problema: estabilidade química de semicondutores com bandgap adequado ao uso de luz visível, na presença de eletrólitos

http://emat-solar.lbl.gov/images/PEC_clip_image002_0000.jpg

Células de Grätzel

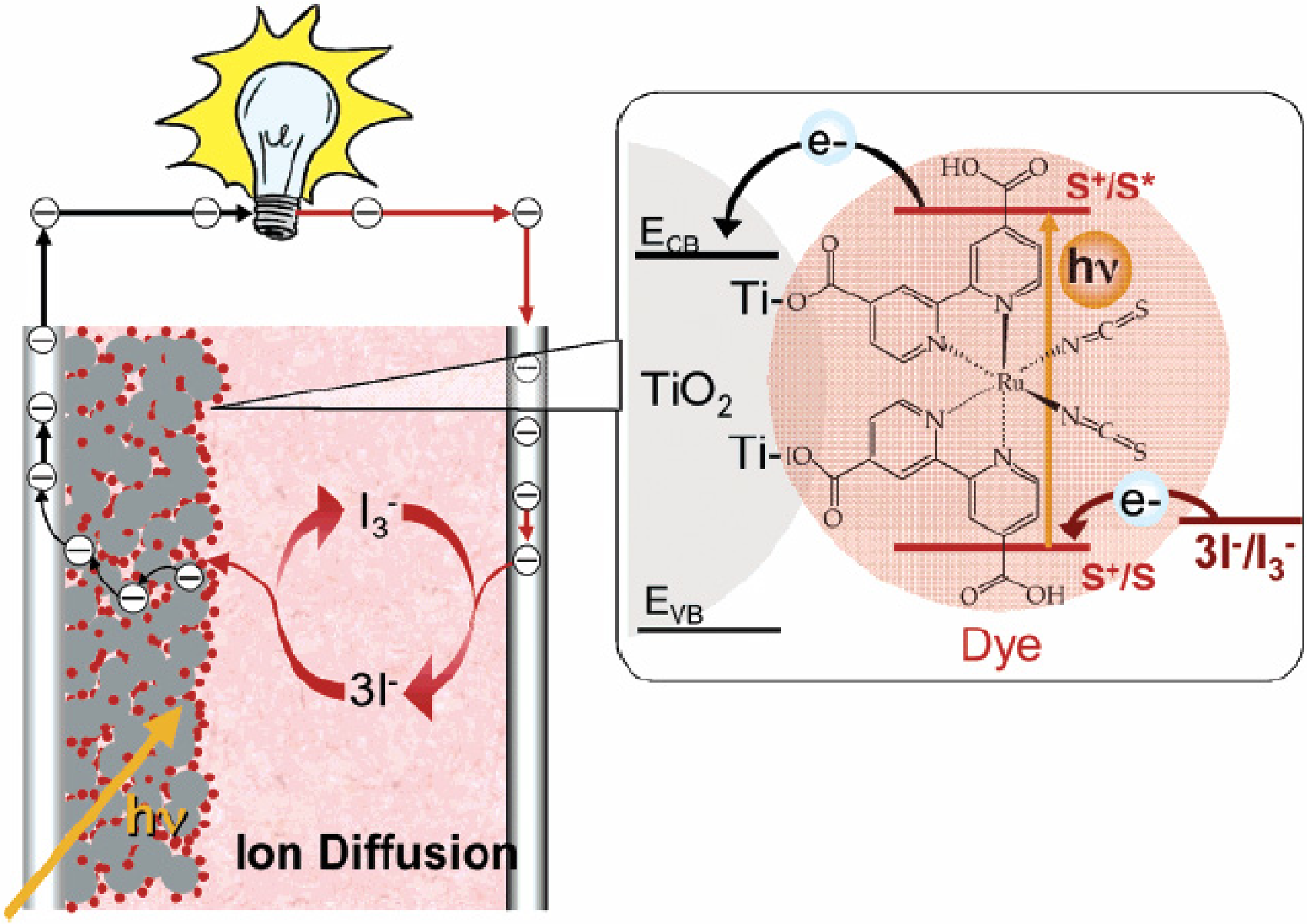


http://www.rsc.org/Education/EiC/issues/2007Sept/HarnessingSolarEnergyGratzelCells.asp



- *Fótons absorvidos por moléculas de corante excitam seus elétrons;*
- *Os elétrons excitados escapam das moléculas de corante para o TiO_2, na banda de condução;*
- *Elétrons se deslocam na banda de condução de TiO_2, até o metal;*
- *O corante oxidado é reduzido por I^-, que se oxida a I_3^-.*
- *I_3^- retira elétrons do eletrodo de grafite, sendo reduzido a I^-.*

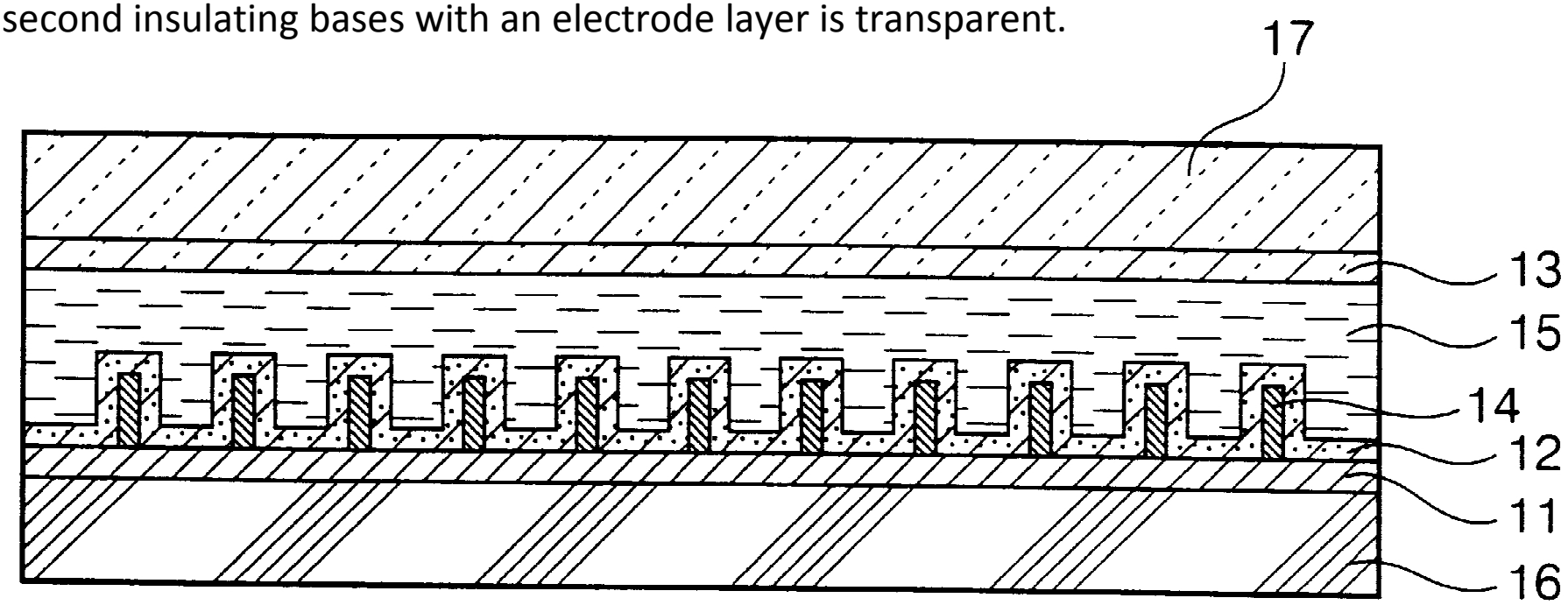
http://mrsec.wisc.edu/Edetc/SlideShow/images/TiO2/gratzel_E.jpg



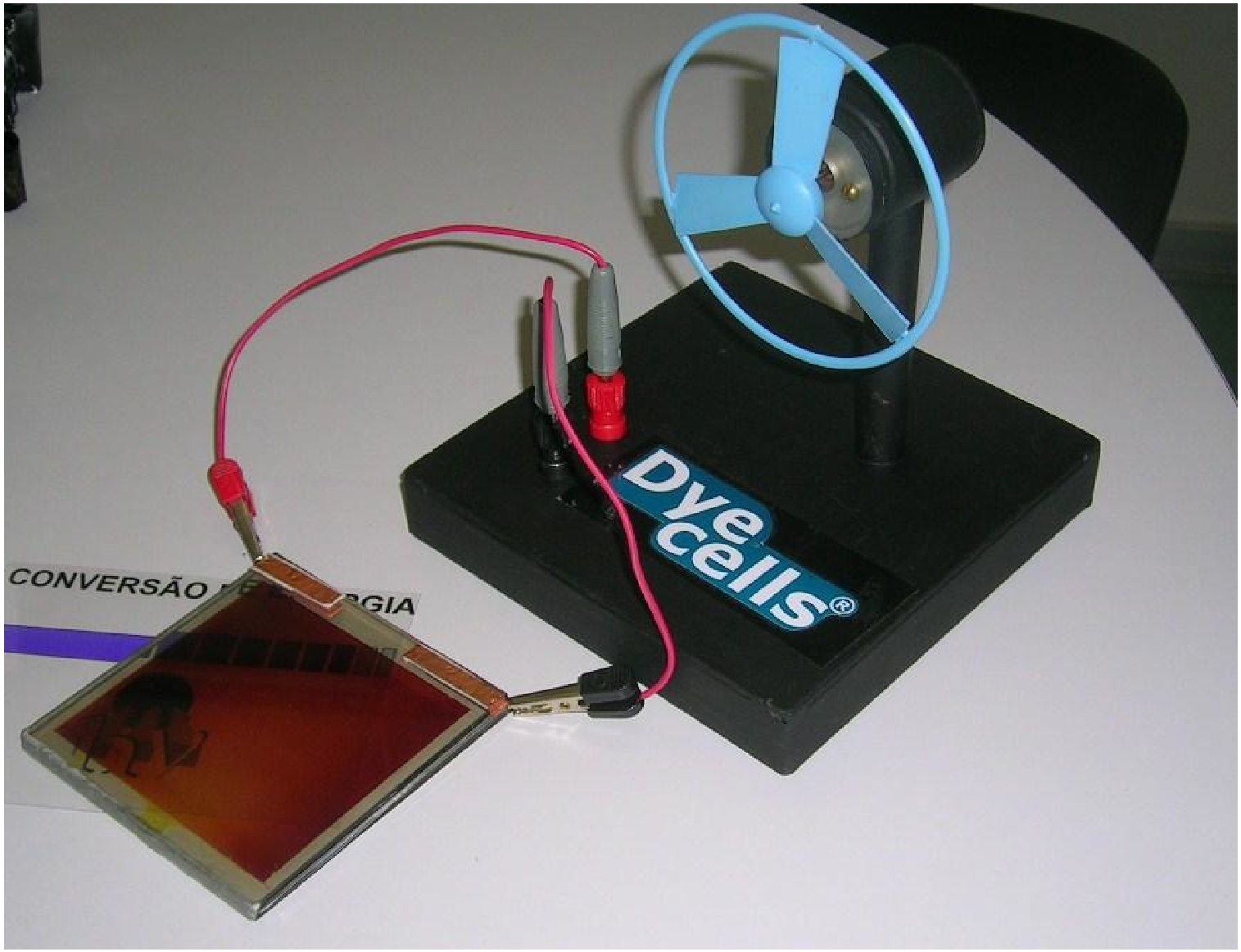
Photoelectric cell and process for producing metal oxide semiconductor film for use in photoelectric cell

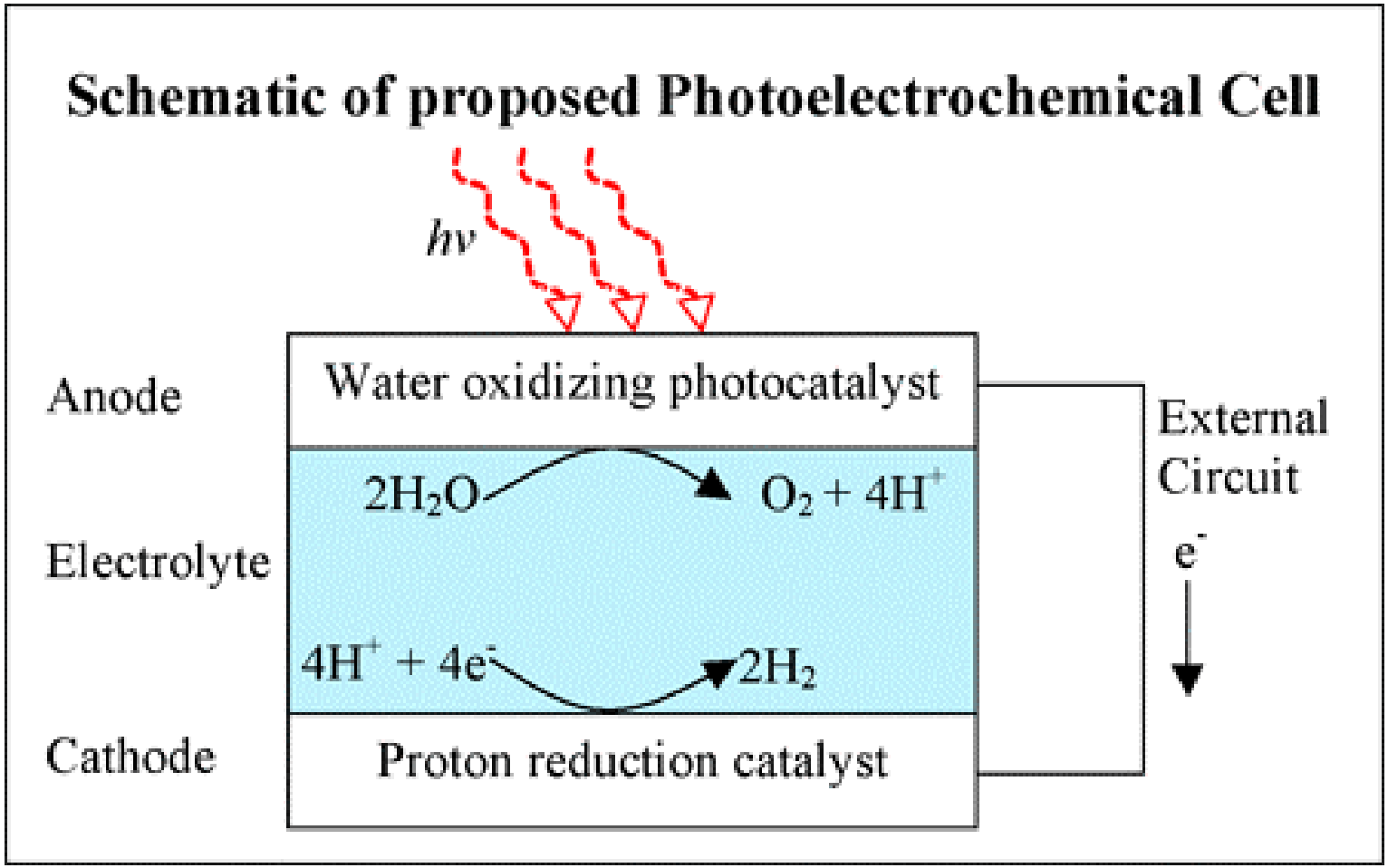
United States Patent 6538194

A photoelectric cell that includes a first insulating base, having on its surface a first electrode layer, which has on its surface a metal oxide semiconductor film, which includes anatase titanium oxide particles, on which a photosensitizer is adsorbed and a second insulating base having on its surface a second electrode layer and an electrolyte sealed between the metal oxide semiconductor film and the second electrode layer. The first electrode layer and the second electrode layer are arranged opposite from each other. At least one of the first and second insulating bases with an electrode layer is transparent.



Usando corante de frutas



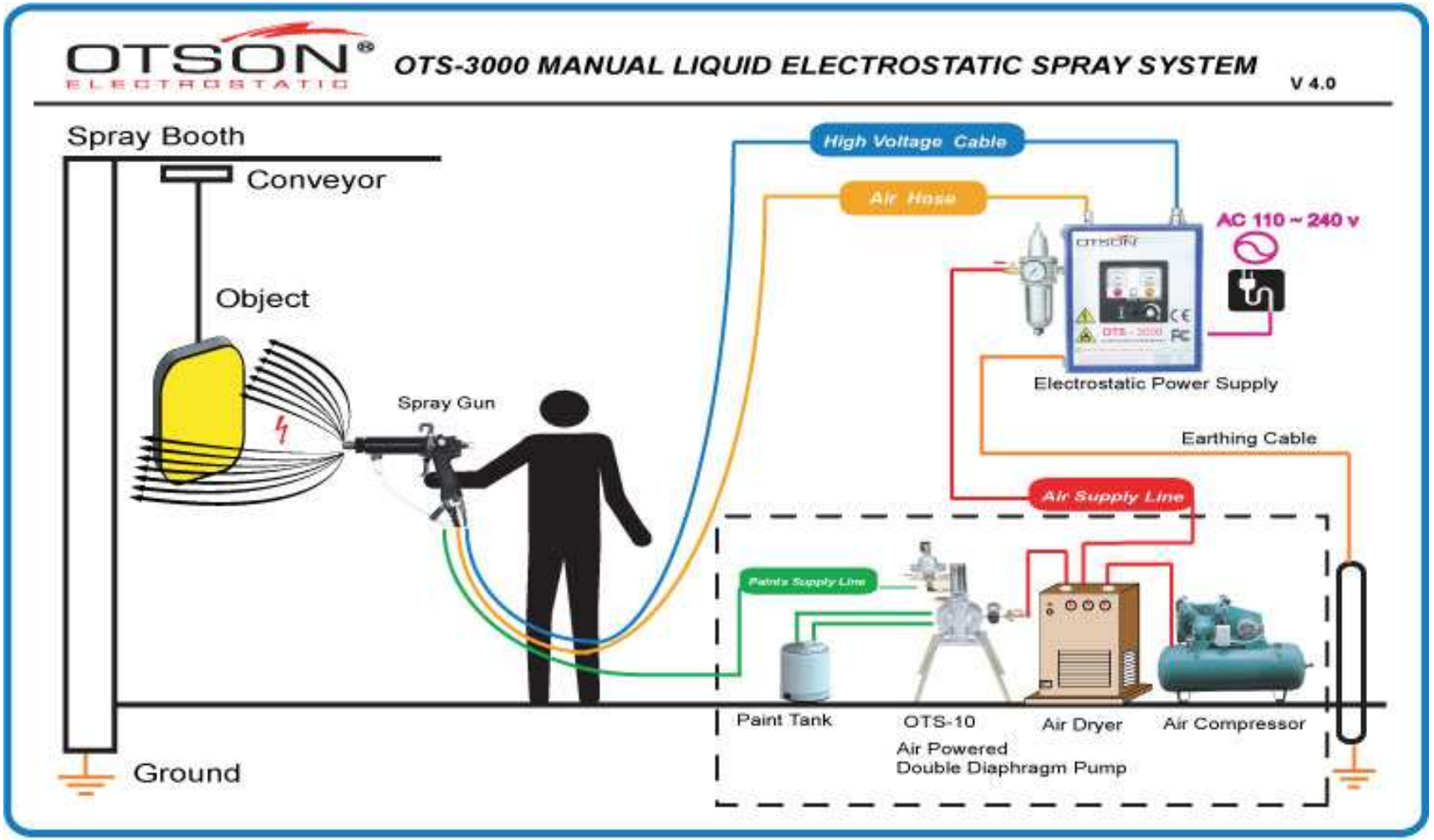

Schematic of proposed Photoelectrochemical Cell
hν
Anode
Water oxidizing photocatalyst
External Circuit
2H2O
O2 + 4H+
Electrolyte
e-
4H+ + 4e-
2H2
Cathode
Proton reduction catalyst

- O catalisador é um complexo de Mn que foto-oxida água produzindo O_2, $4e^-$ e 4 íons H^+. Acoplado a ele está um complexo de rutênio que, uma vez excitado, facilmente injeta um elétron em uma camada de TiO_2, que o transfere para o eletrodo.
- Elétrons resultantes da oxidação da água reduzem o complexo de rutênio, fechando o circuito.
- Elétrons re-entram no sistema pelo outro eletrodo, reduzindo protons e formando H_2.
- Dez células produzem $31 \pm 7\ \mu A \cdot cm^{-2}$.
- Solar Driven Water Oxidation by a Bioinspired Manganese Molecular Catalyst, R. Brimblecombe, A. Koo, G. C. Dismukes, G. F. Swiegers, L. Spiccia, J. Am. Chem. Soc. 2010, 132, 2892.]

- http://beautifulphotochemistry.wordpress.com/

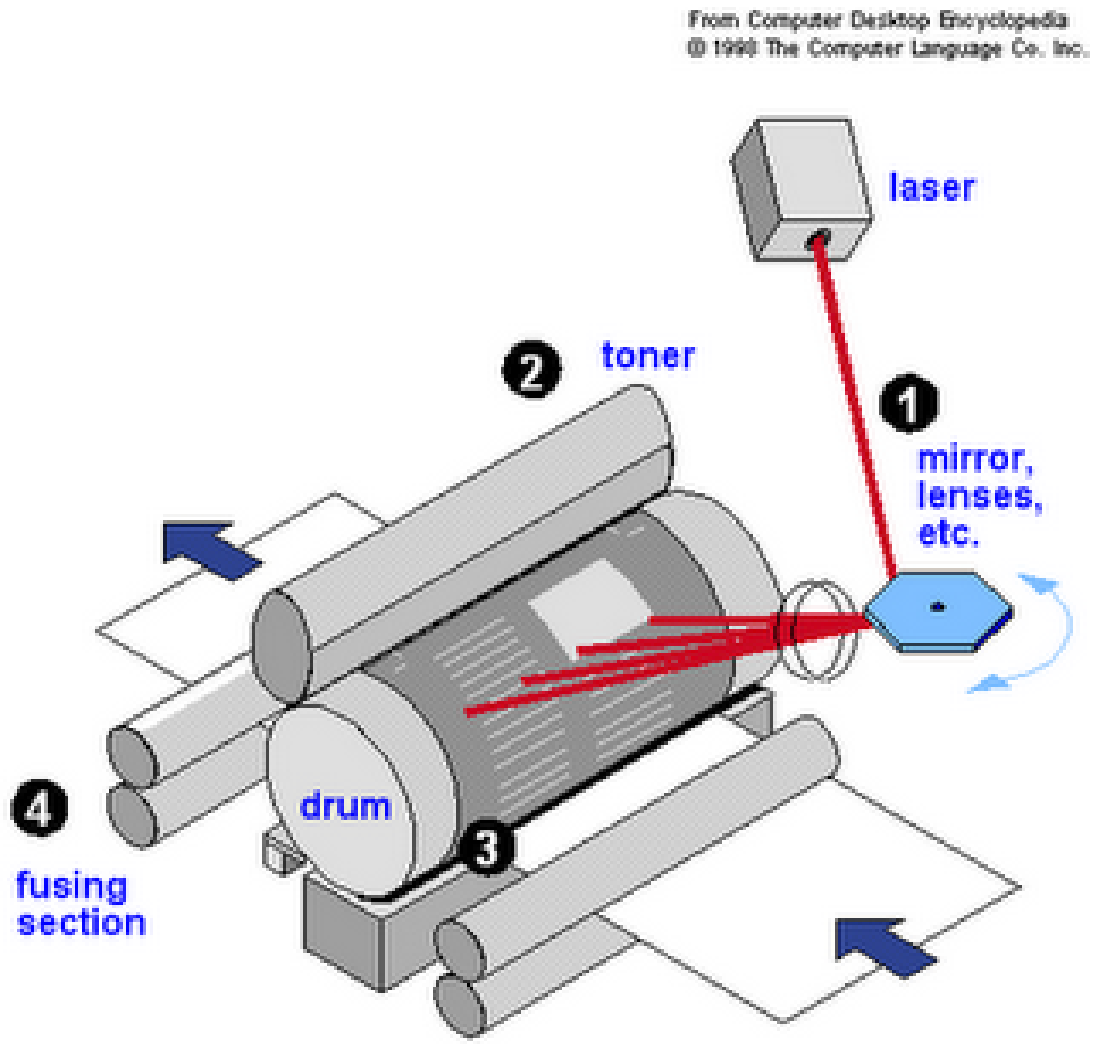
Processos eletrostáticos

Pintura eletrostática



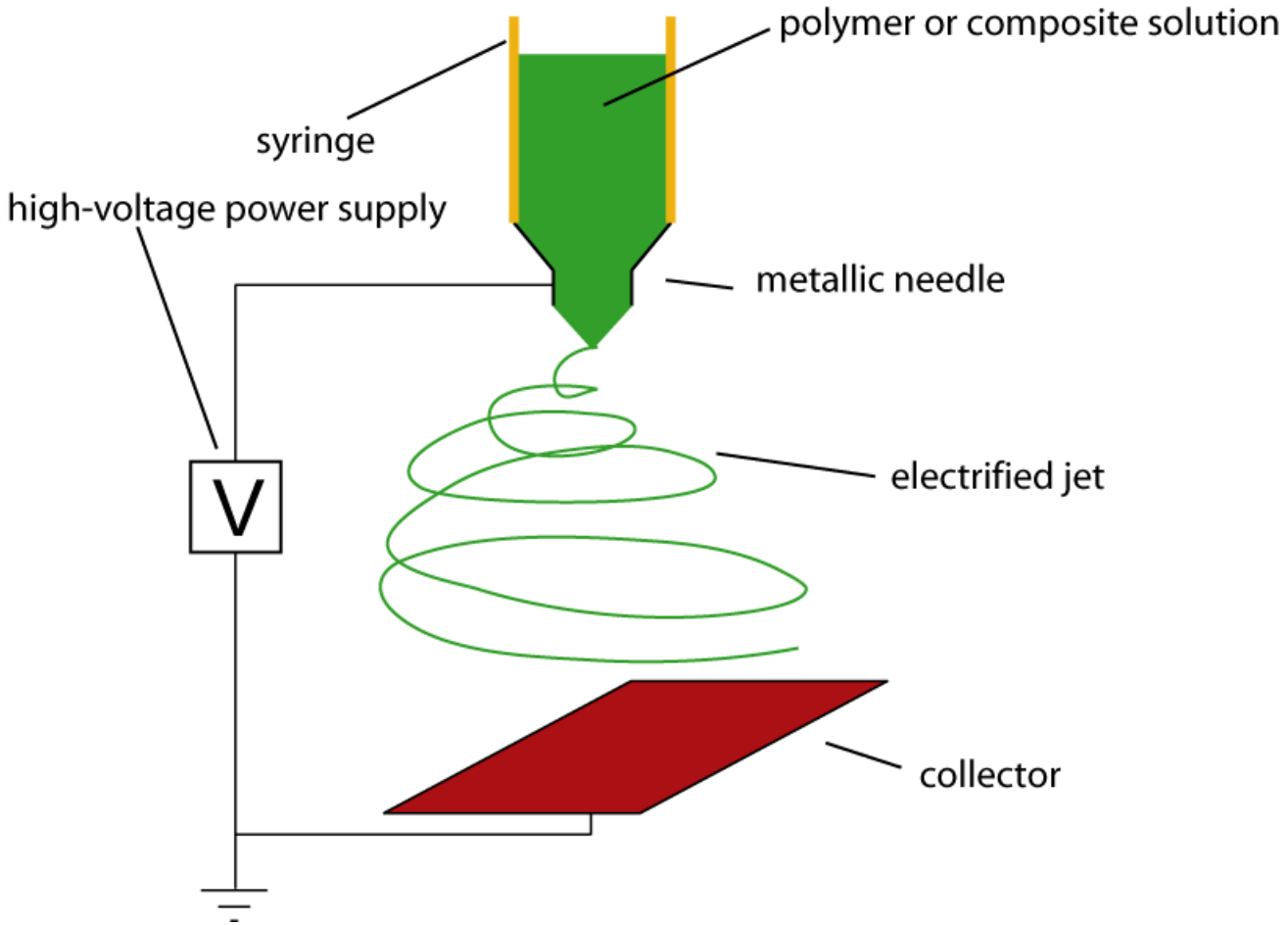
http://www.electrostatic-spray-gun.com/Electrostatic-Painting.html

Impressoras a laser e xerocopiadoras

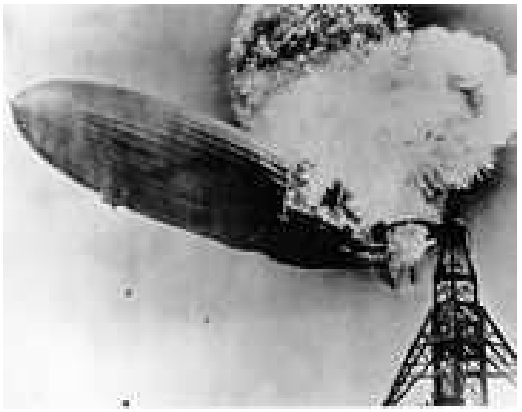


http://eletromagnetismoifes.blogspot.com/2009/03/pintura-eletrostatica_03.html

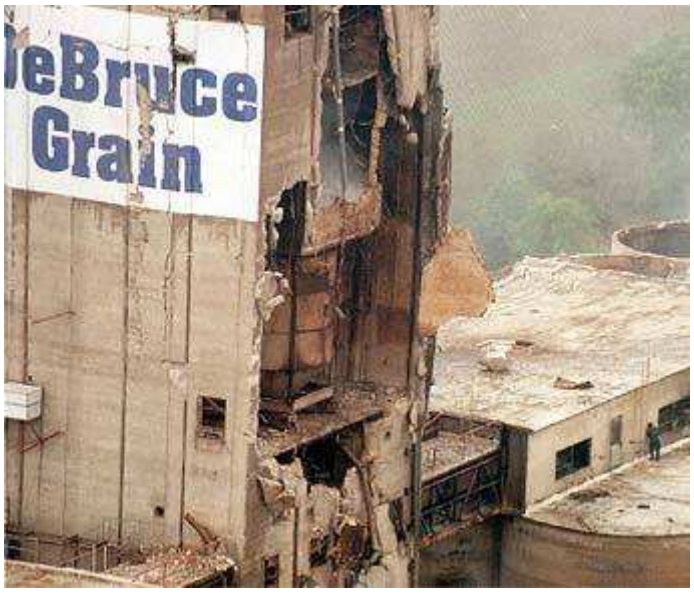
Eletrofiação



http://upload.wikimedia.org/wikipedia/commons/1/19/Electrospinning_setup.png



Dust explosions are often triggered by electrostatic discharge



The first dust explosion that was outlined in a world literature occurred in 14 December 1785 in Italy. Turin Science Academy noticed that it was an explosion of flour dust in the centre of Turin. According to literature all building was destroyed - reported by Rafal Porowski from HQ of SFS.
http://www.ppoz.pl/wwwold/current.htm

"…current geophysical research has not yet disclosed effective models for atmospheric cloud electrification."

Helsdon Jr., J. H.; Gattaleeradapan, S., Farley, R. D.; Waits, C. C. *J. Geophys. Res.* **2002**, *107*, 4630.

Electrostatic charging: an old but still unsolved problem

"…it remains among the most poorly understood areas of solid-state physics."

Schein LB

Recent progress and continuing puzzles in electrostatics.

Science, 316, 1572-1573 (2007).

Do we understand contact charging of insulators?

- "…one of the earliest manifestations of electrical science."
- "Yet reproducible experiments remain a challenge."
- "A …theory of …charging remains elusive."
  - *Castle, J. Electrostatics 1997*

- "…the charging of insulators comes from a transfer of electrons, of ions, or of both?"
  - Montgomery: ***always*** electrons
  - Loeb: ***generally*** electrons
  - Henry ***feels*** that the question is ***still an open one***.
  - I (Harper) am of the opinion... carriers are ***never*** electrons … in an insulator."

    Bailey, J. Electrostatics 2001