ARTIFICIAL PHOTOSYNTHESIS

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INTRODUCTION

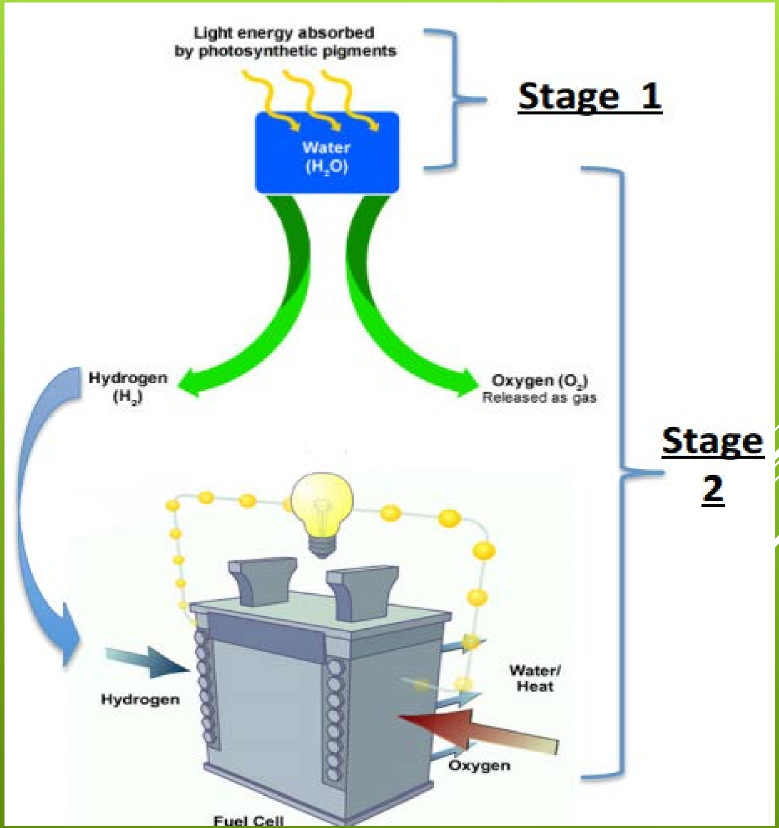
- One of the most promising emerging technologies
- Many practical applications
- Highly environmentally friendly
- Progression towards hydrogen economy

HISTORY

- 1912 - Discussed by Giacomo Ciamician
- 1960s - TiO_2 found to have photocatalytic properties
- 2000s - Rapid increase in AP research
- 2000 - CSIRO emphasizes CO_2 reduction
- 2008 - MIT discovered cheaper materials for catalysts

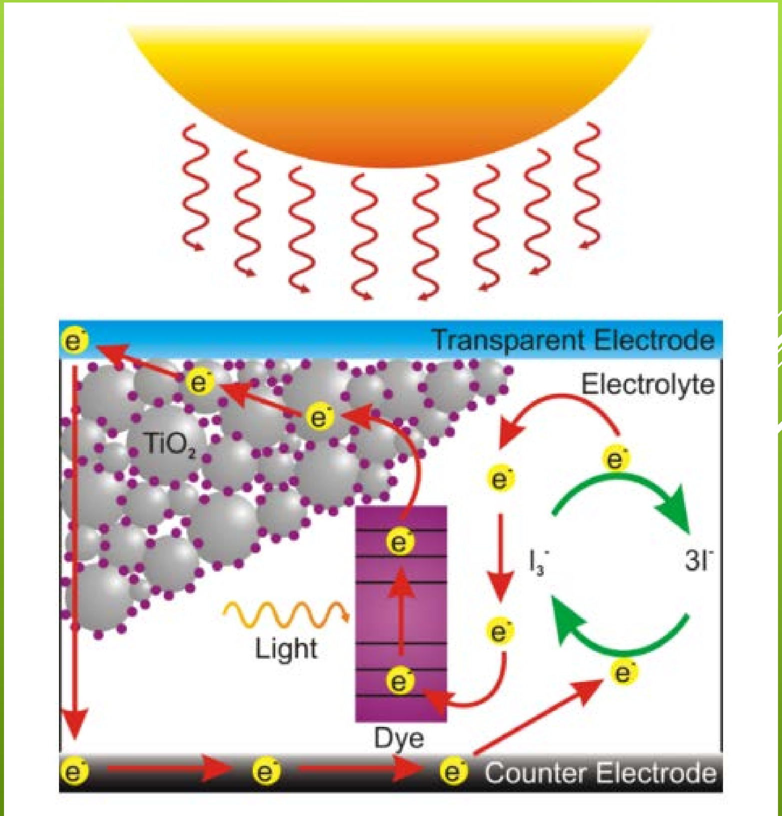
PROCESS

1. Artificial photosensitizer absorbs energy from sun
2. Energy used in electrolysis
3. Hydrogen flow creates current
4. Oxygen and water as byproduct



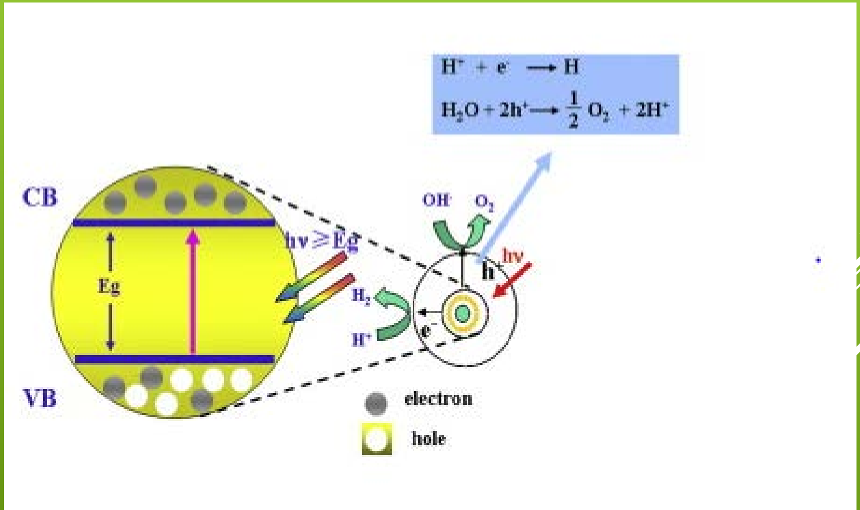
DYE-SENSITIVE SOLAR CELL

- Nanocrystalline TiO2 acts as chloroplast
- Dye used to capture light energy
- Peak efficiency at about 15%
- Process
  - Photosensitizers absorbs photon
  - Photosensitizer excited from ground state, added to conduction band of TiO2
  - Diffusion to contact
  - I- provides electrons returning photosensitizer to ground state



PHOTOCATALYTIC WATER SPLITTING

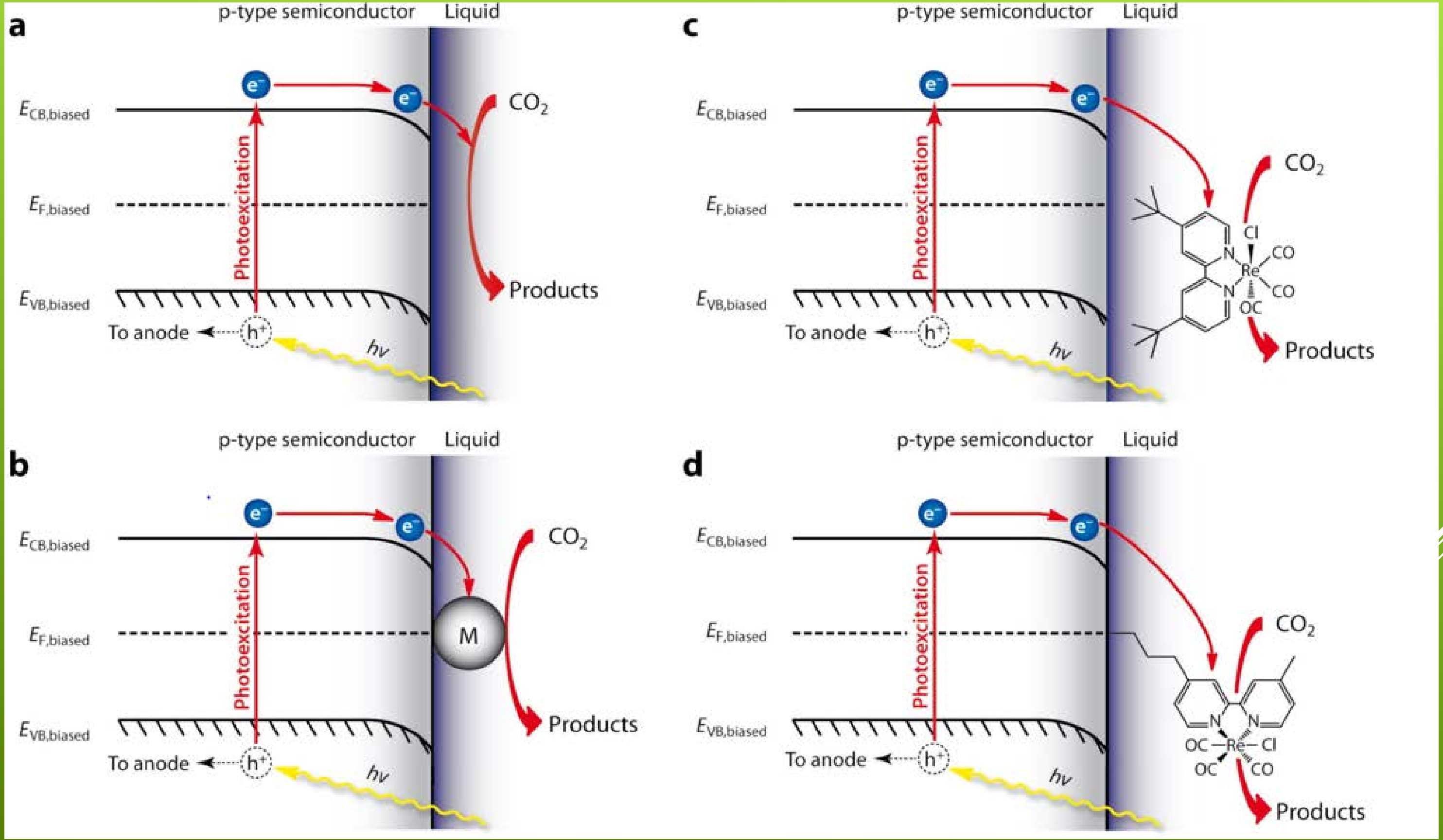
- Hydrogen creation difficult due to
  - Recombination
  - Back reaction
  - Efficient light utilization
- CdS based photocatalyst
- Solid Solution photocatalyst
- Composite photocatalyst



ELECTROCHEMICAL CO2 REDUCTION

- Most challenging aspect
  - CO2 to CO
  - Thermodynamic potentials too high
  - Low efficiency
- Homogeneous photocatalytic reduction
  - Photosensitizer
- Heterogeneous photocatalytic reduction
  - p-type semiconductor
  - Aqueous vs. nonaqueous

ELECTROCHEMICAL CO2 REDUCTION



ADVANTAGES AND DISADVANTAGES

- Huge environmental impact, could revolutionize energy industry in general
    - CO_2 reduction
    - No more reliance on fossil fuels
- Self sustaining and easy to utilize
- Untapped resource in solar
- Expensive to make so far, not efficient enough
- Smaller lifespans than general photovoltaic cells

FUTURE OF ARTIFICIAL PHOTOSYNTHESIS

- Solution for global warming?
  - Continued efforts at efficient CO_2 reduction
- New devices becoming more efficient, higher hydrogen output
- Possible creation of hydrocarbon and polymers
- Mars habitation

SOURCES

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