

Bionic Leaf



Abdul Waheed
School of ECE Georgia Tech
ECE 4803

Overview

Objective

Introduction

Processes

Device Structure

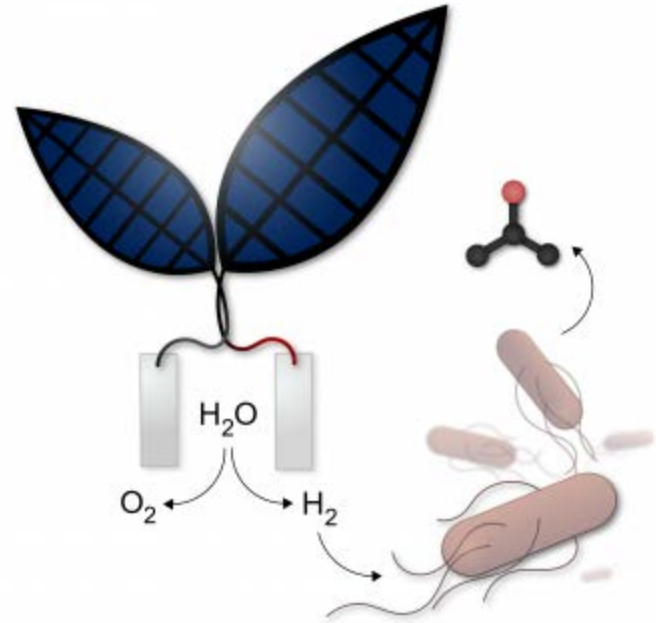
Advantages

Objective

Explore the design and working of bionic leaf, that converts solar energy into a liquid fuel.

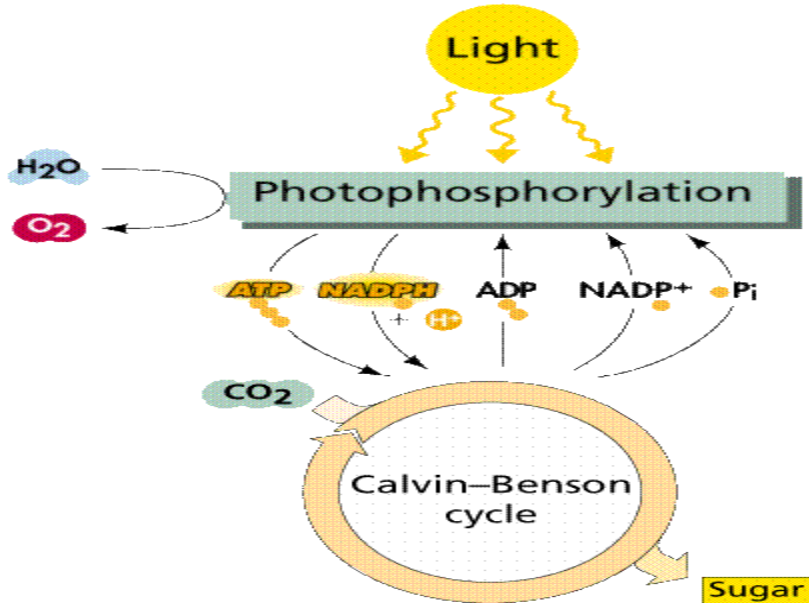
Introduction

- Bionic leaf mimics photosynthesis.
- Created at Harvard University.
- Artificial leaf, sandwiching photovoltaic cell, forms the heart of bionic leaf.



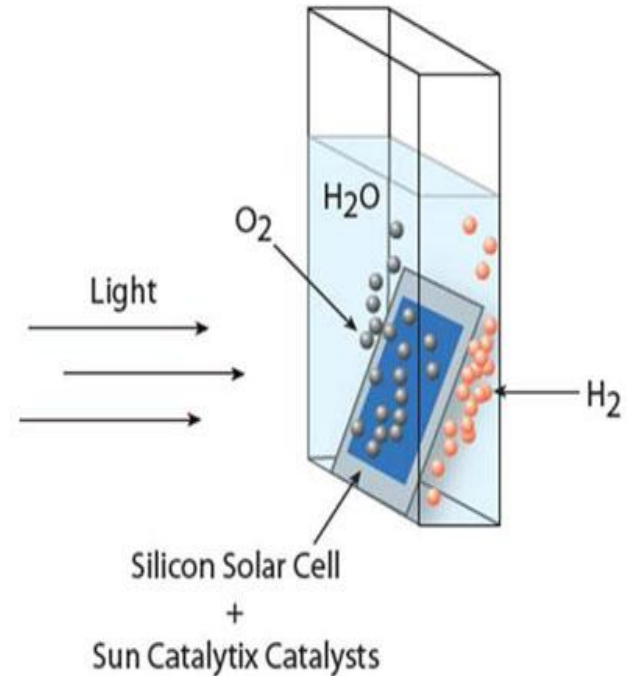
Photosynthesis

- Photosynthesis



Artificial Leaf

- Artificial photosynthesis
- Solar energy stored as chemical energy in hydrogen gas

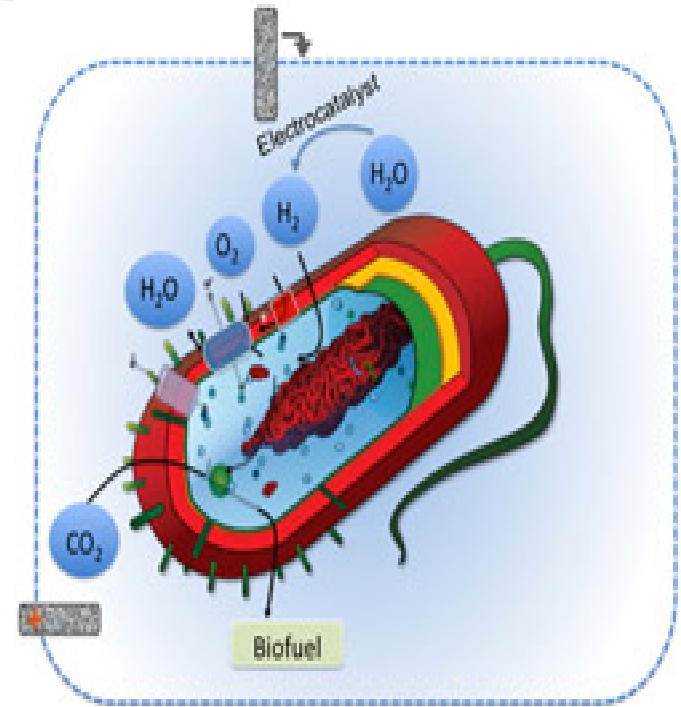


Artificial Leaf

- Solar cell and catalyst coupled into one device
- Artificial leaf setup vs. an array of PV panels
- A plant leaf efficiency is 1%
- Artificial leaf is at 7%

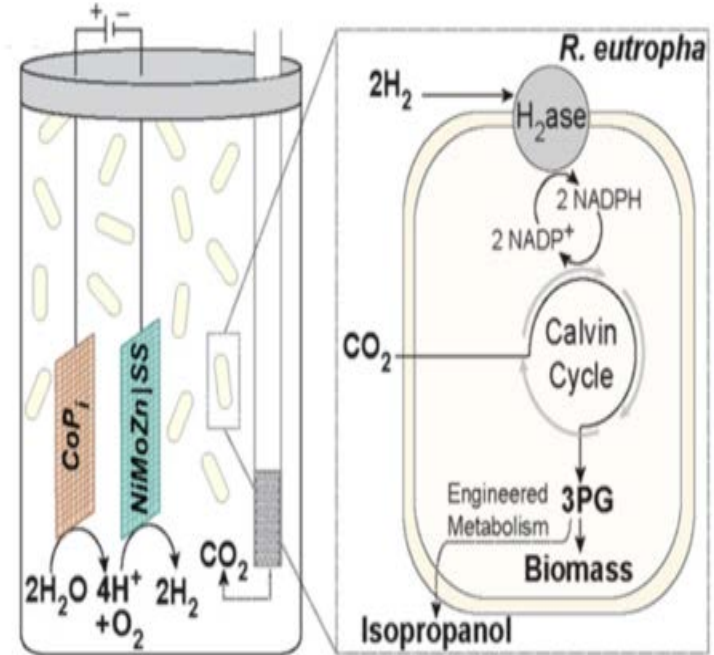
Ralstonia Eutropha

- The fuel machine in a bionic leaf
- Form polymers under stress
- By breathing CO_2 and H_2 , produce branched alcohol (energy source)



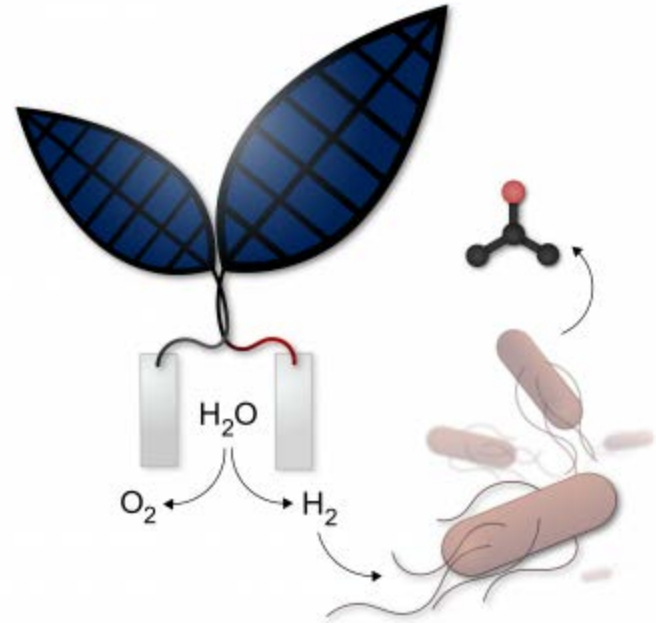
Bioelectrochemical Cell

- Water oxidation at Cobalt Phosphate and reduction at cathode
- CO₂ is pumped in
- *Ralstonia eutropha* produce biomass using H₂ and CO₂



Bionic Leaf

- Bionic leaf combines the PV water-splitting wafer with *Ralstonia eutropha*
- Splits water into H_2 and O_2
- *Ralstonia eutropha* convert H_2 and CO_2 into isopropanol



Bionic Leaf

- Can pump 216 mg of isopropanol, efficiency of a corn plant making starch
- Efficiency improved by using starved microbe

Advantages

- Reverse combustion
- Efficient bionic leaf can produce fuel, pharmaceuticals and other useful molecules
- Oil and gas are cheaper in comparison but not sustainable

References:

- [1] Torella, J.P. (1), et al. "Efficient Solar-To-Fuels Production From A Hybrid Microbial-Water-Splitting Catalyst System." *Proceedings Of The National Academy Of Sciences Of The United States Of America* 112.8 (2015): 2337-2342. *Scopus®*. Web. 9 Nov. 2015
- [2] Owen, David. "The Artificial Leaf." *New Yorker* 88.13 (2012): 68-74. *Literary Reference Center*. Web. 9 Nov. 2015.
- [3] Janna Olmos, J.D. (1,2), and J. (1) Kargul. "A Quest For The Artificial Leaf." *International Journal Of Biochemistry And Cell Biology* 66.(2015): 37-44. *Scopus®*. Web. 9 Nov. 2015.
- [4] <http://harvardmagazine.com/2015/05/the-bionic-leaf>
- [5] <http://www.scientificamerican.com/article/bionic-leaf-makes-fuel-from-sunlight/>
- [6] <http://www.mnn.com/earth-matters/energy/stories/bionic-leaf-can-convert-solar-energy-into-liquid-fuel>
- [7] <https://hms.harvard.edu/news/bionic-leaf>
- [8] <http://www2.estrellamountain.edu/faculty/farabee/BIOBK/BioBookPS.html>