ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Design of Optofluidic Components for an Integrated Electrolyzer

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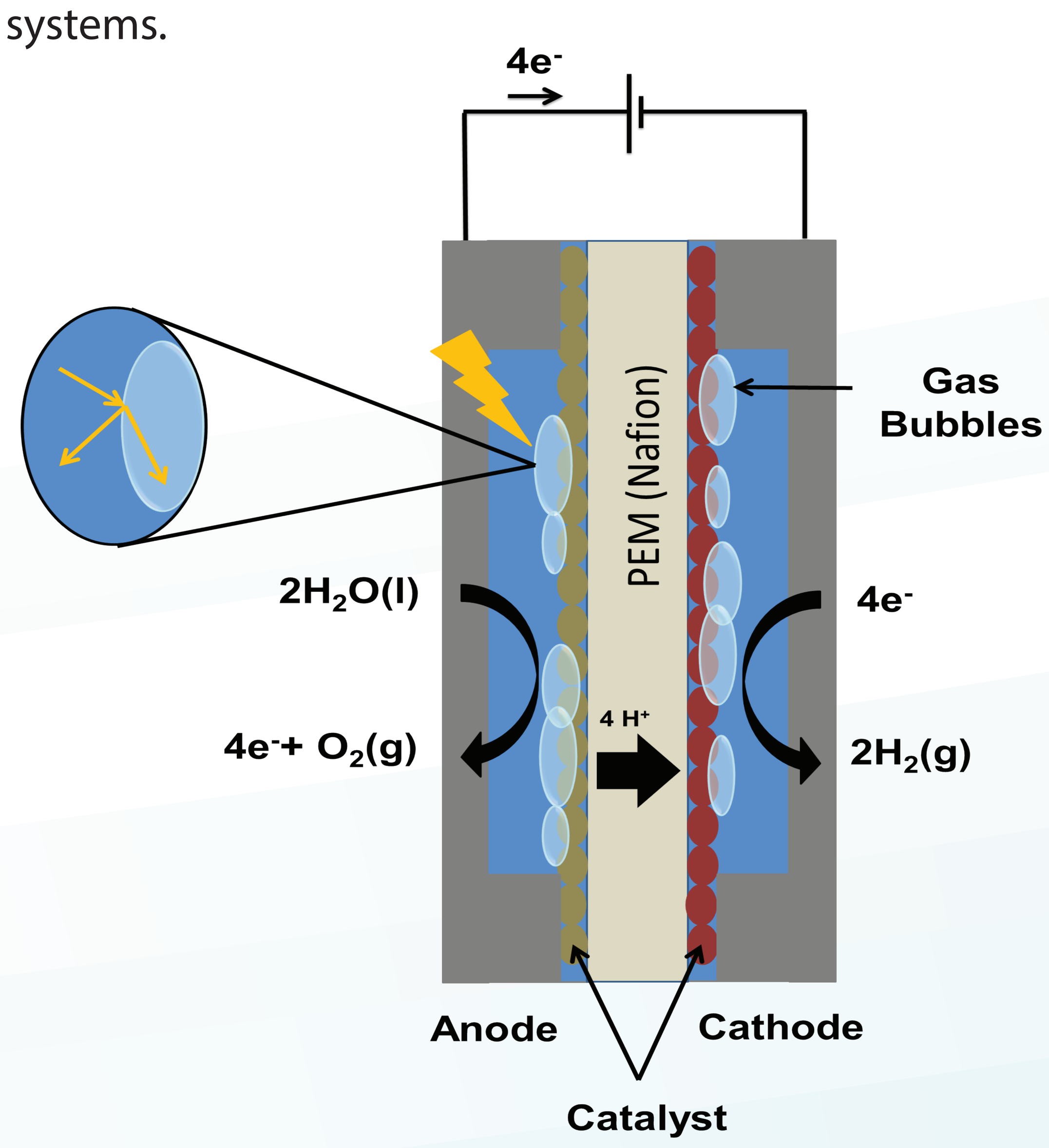
INTRODUCTION

Design and fabrication of three mini/microfluidic devices [1]:

- A photothermal microreactor for water decontamination.
- An optofluidic vapor generator to feed a microelectrolyzer.
- A vapor-fed and a liquid-fed microelectrolyzer for water splitting and separation of gaseous products.

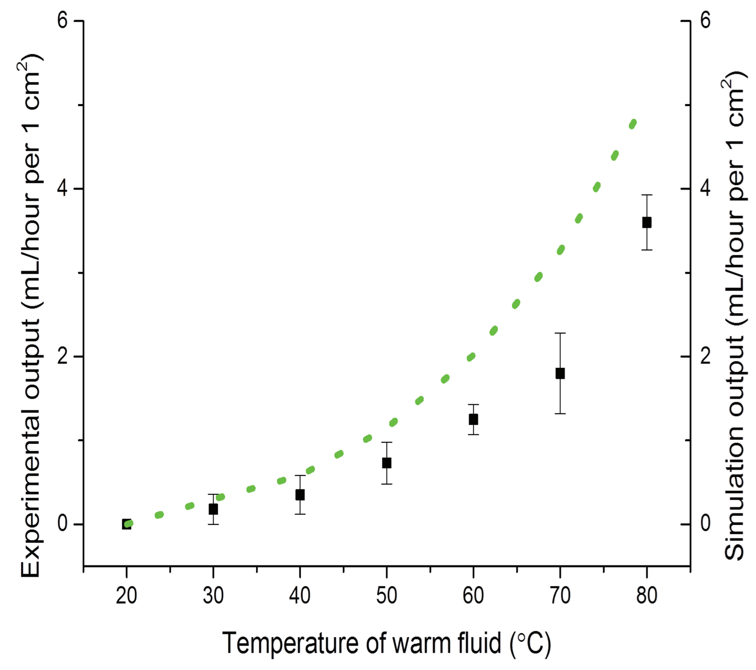
Advantages of vapor-fed system [2]:

- Circumventing the mass transport limits imposed by the gas bubbles.
- Preventing scattering/refraction from gas/liquid interface in liquid systems.

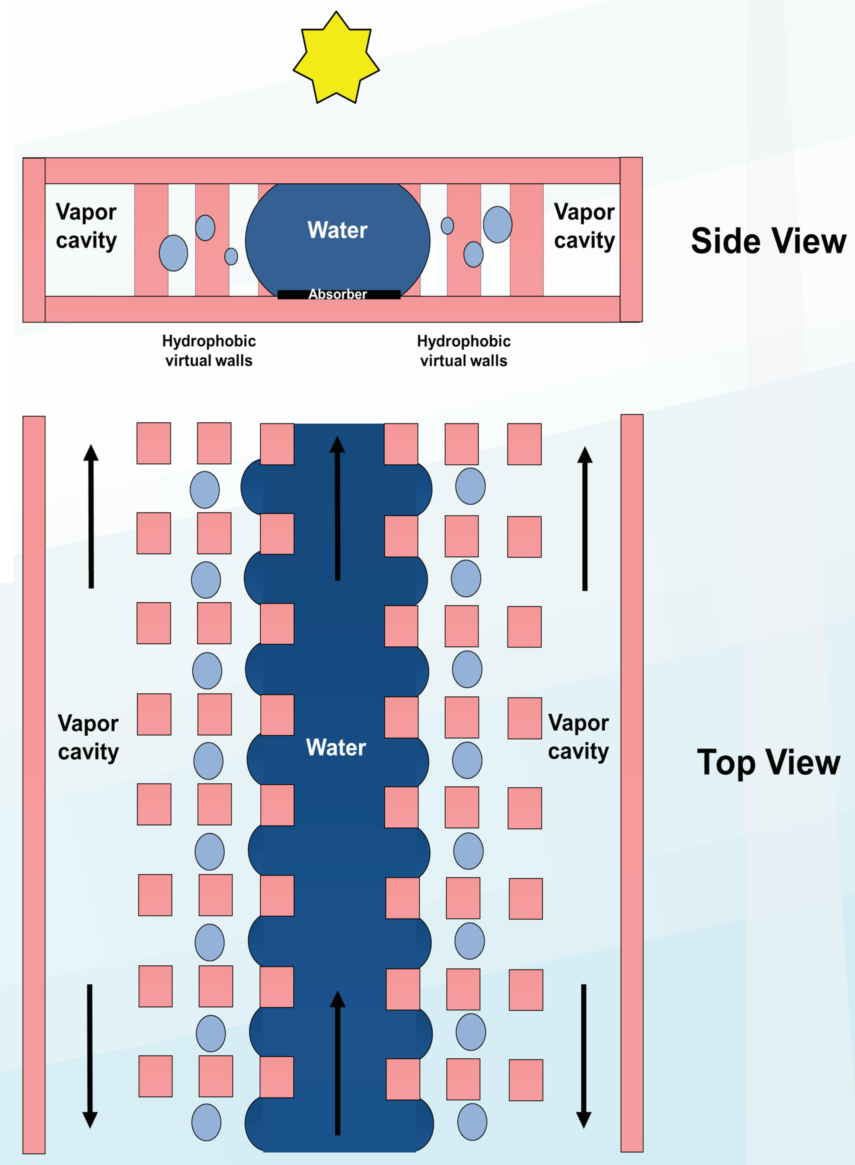


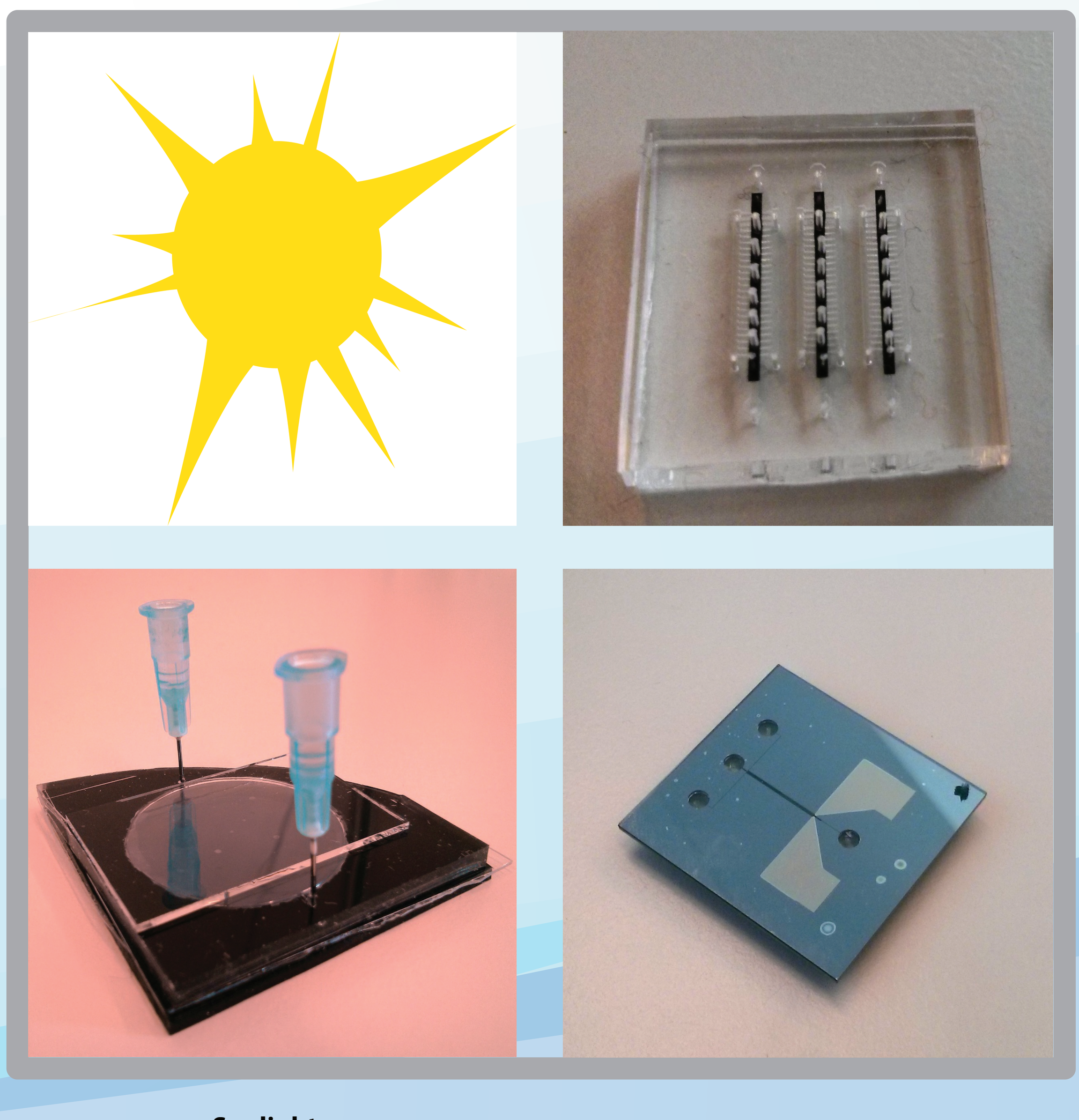
VAPOR GENERATOR

- Integration of carbon black absorbers in microchannels to heat up the input water.
- PDMS micropillars increase the hydraulic resistance in the cross-flow direction.
- Only water vapor can enter the side channels due to this large hydraulic resistance [4].



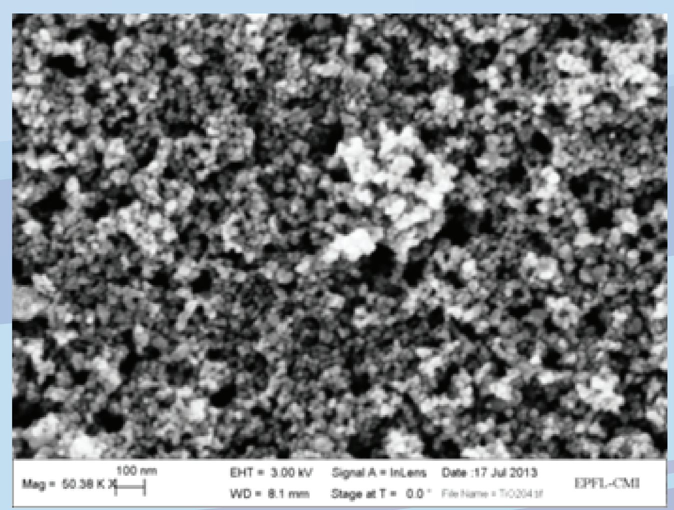
Evaporation rate as a function of water inlet temperature

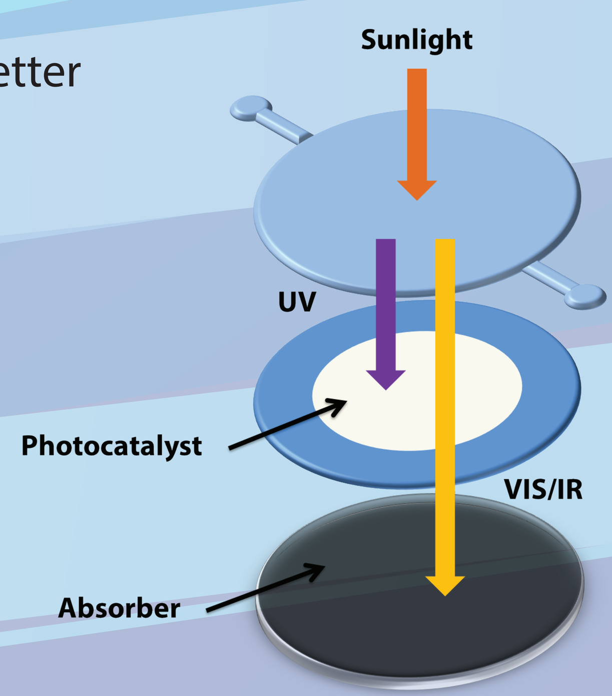


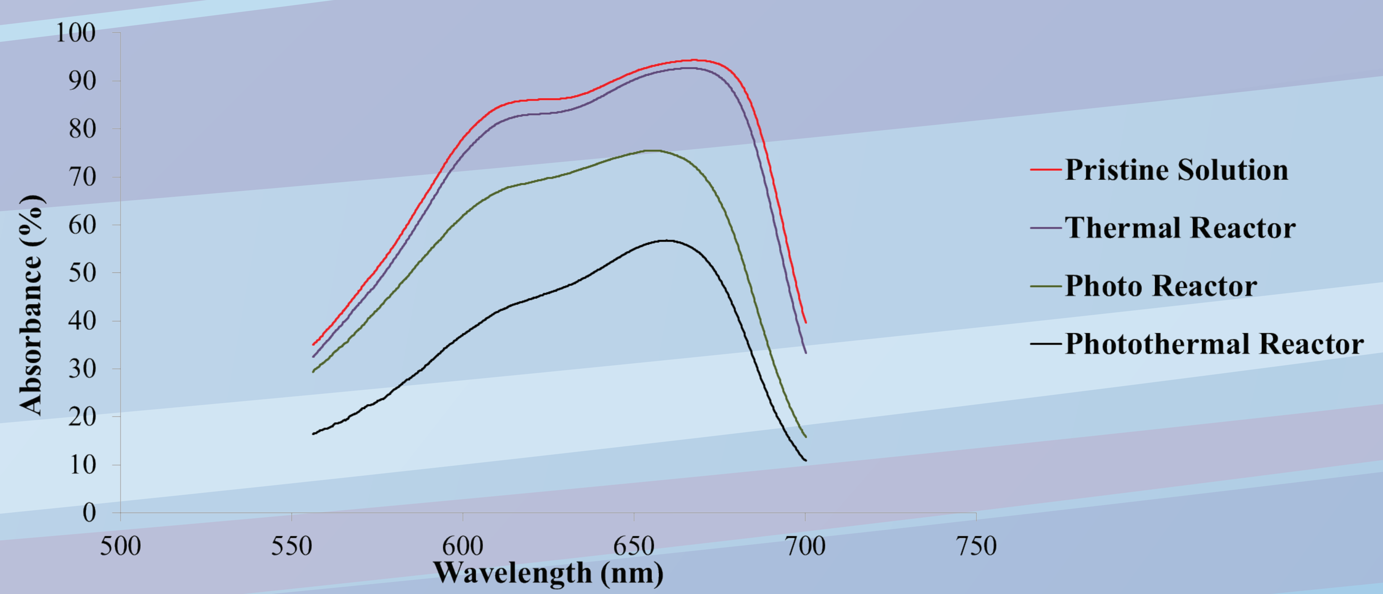


THERMAL MANAGEMENT

- Only a small portion of sunlight is used for catalysis in semiconductor photocatalysts.
- The rest is available as heat.
- A photoreactor is designed and fabricated to tap into this heating component.
- UV light is used by Titania, visible and infrared are thermalized by the black absorber.
- The photothermal reactor performs 82% better than the photoreactor [3].



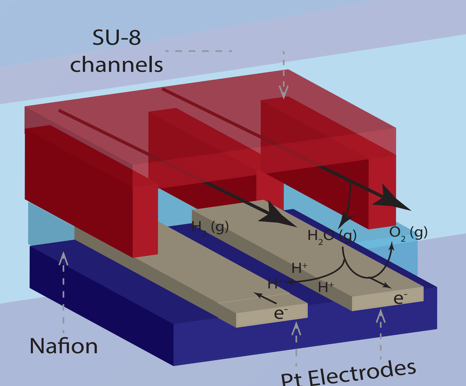


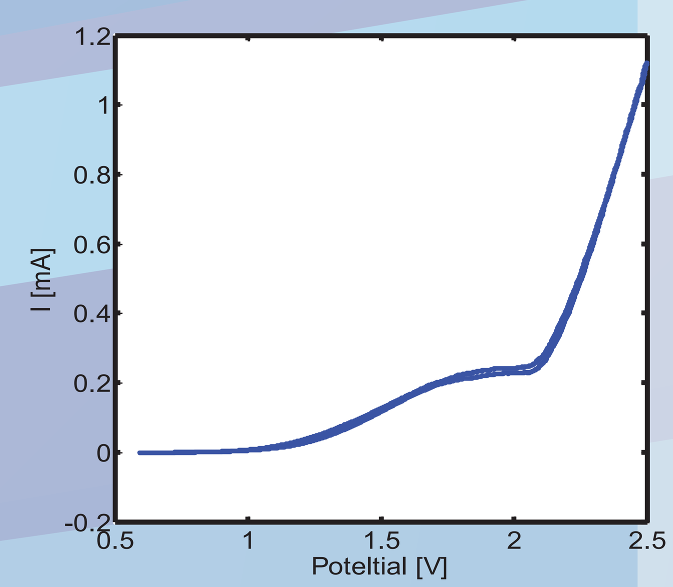


MICROELECTROLYZER

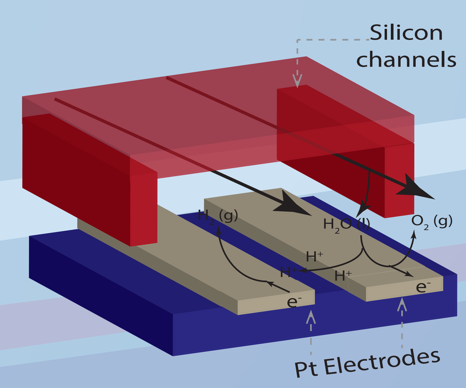
- Design and fabrication of a vapor-fed and a liquid-fed microelectrolyzer.
- Platinum electrodes are patterned on glass and fluidic channels are made out of SU8 or Silicon.
- In vapor fed system Nafion is used as an ion conductive membrane.
- In liquid fed system, the gas cross-over problem is under study.

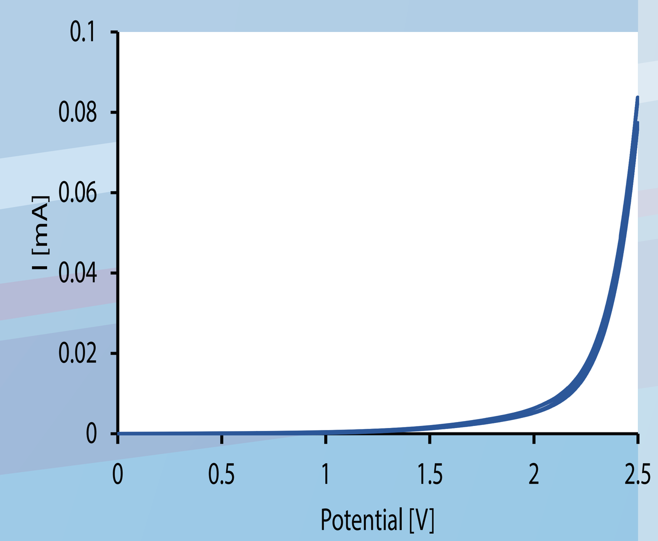
Vapor fed system





Liquid fed system





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2. Spurgeon, J. M., & Lewis, N. S. (2011). Proton exchange membrane electrolysis sustained by water vapor. Energy & Environmental Science, 4(8), 2993-2998.
3. Hashemi, S. M. H., Choi, J. W., & Psaltis, D. (2014). Solar thermal harvesting for enhanced photocatalytic reactions. Physical Chemistry Chemical Physics.
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