

Solar Energy Conversion: Photosynthesis



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Levi Cases Retreat Day

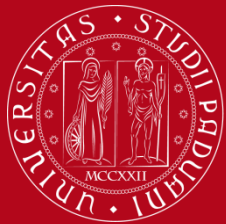
Monday, January 18th, 2016

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Outline

- State of the art and open issues
 - Ways to convert photons into chemicals
 - Microalgae and cyanobacteria
- Levi-Cases Projects
 - N.1 (coordinator: Fabrizio Bezzo): A photobioreactor-on-a-chip technology for assessing and optimising photosynthetic activity in microalgae-based fuel production
 - N.2 (coordinator: Tomas Moronosinotto): Genetic improvement of unicellular algae to produce biofuels
 - N.3 (coordinator: Giovanna Brusatin): Nano-structuring artificial photosynthesis for solar fuel production



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To produce biomass or to obtain water splitting

- Intensification of natural Photosynthesis
 - Wild types
 - Mutants
 - GMO
- Photocatalysis:
 - Daniel Nocera (Science, 2011)
 - nanomaterials
- Artificial Photosynthesis (?)



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Pros and cons of microalgae and cyanobacteria @LC

- Valuable features
 - Both direct light and diffused light exploited
 - Biomass without lignine
 - Growth rate much higher than terrestrial plants
 - Simpler GMO to improve quality (cyanobacteria)
 - Very hot topic (not only bioenergy, also CO₂ capture)
 - Highly qualified interdisciplinary group - PARlab
- Constraints:
 - Maximum areal productivity : 300 t/(ha y)
 - Maximum photosynthetic efficiency: 12%
 - Current technology efficiency: 3%



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Project 1 (research project)

A photobioreactor-on-a-chip technology for assessing and optimising photosynthetic activity in microalgae-based fuel production

- Objectives:
 - A high throughput device to analyze experimentally the interaction of different phenomena in algae cultivation (photoproduction, photoinhibition, photoregulation and photoacclimation)
 - A simulation model tuned on experimental results
- Work in progress:
 - Design and verification of the device already done in batch
 - Research on continuous operation just started
- However:
 - No papers published nor proceedings so far



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Project 2 (PhD)

Genetic improvement of unicellular algae to produce biofuels

- Objective:
 - Engineering wild type microalgal strains with a photosynthetic apparatus more efficient for industrial applications
- Work in progress:
 - Interesting mutants of *Nannochloropsis gaditana* found
 - Molecular characterization of these mutants studied
- In addition:
 - 1 paper published and 2 proceedings so far, with indication of affiliation to Levi Cases



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Project 3 (PhD)

Nano-structuring artificial photosynthesis for solar fuel production

- Objectives:
 - Development of photosynthetic assemblies based on nanocarbon composites and high surface graphene to integrate water splitting catalysts and antenna-type sensitizers
 - Integration of functional electrodes in a microfluidic system, designed to collect separately O₂ and H₂
 - Use of Scanning Ion Conductance Microscopy (SICM) for biological (?!) and electrochemical applications
- Work in progress:
 - Development of SICM technique
- However:
 - No papers published nor proceedings so far