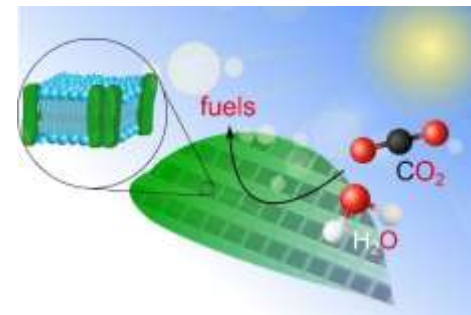




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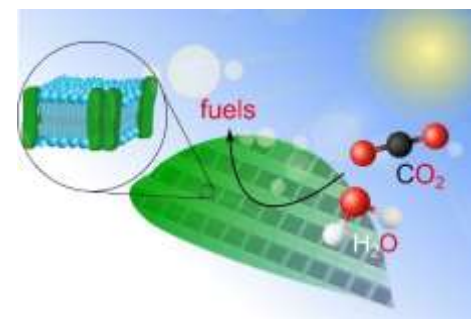
Kick-off US-German Workshop Series 2021-2022



Workshop committee:

Frances Houle	Lawrence Berkeley National Laboratory, US
Thomas Hannappel	Technische Universität Ilmenau, DE
Lin X. Chen	Argonne National Laboratory, US
Beatriz Roldán Cuenya	Fritz Haber Institute of the Max Planck Society, DE
Jillian Lee Dempsey	University of North Carolina, US
Stefanie Gräfe	Jena University, DE
Matthias Beller	Leibniz Institute for Catalysis, DE
Gary Brudvig	Yale University, US
Daniel Esposito	Columbia University, US
Wolfram Jaegermann	Technische Universität Darmstadt, DE
Shane Ardo	University of California, US
Ian Sharp	Technische Universität München, DE

Kick-off US-German Workshop Series 2021-2022



- 05.00 - 05.20 **Welcome and introduction of the goals of the workshop series**
Dr. Frances Houle, Lawrence Berkeley National Laboratory, US
Prof. Thomas Hannappel, TU Ilmenau, DE
- 05.20 - 06.30 **Artificial photosynthesis - state of the art from the US and German perspective**
Prof. Harry Atwater, Caltech, US
(5 minute break)
Prof. Wolfram Jägermann, TU Darmstadt, DE
- 06.30 - 07.00 **Discussion**



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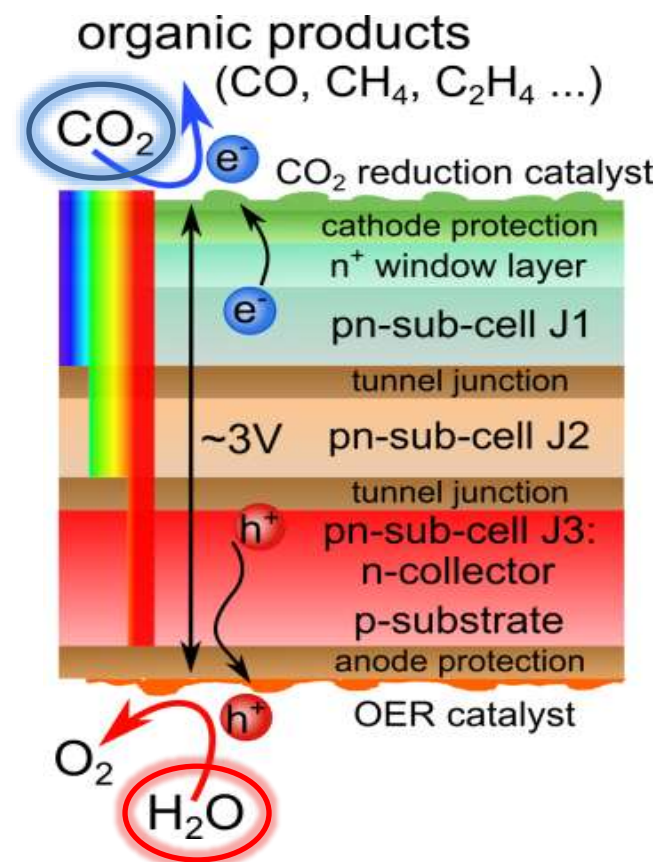
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Thank you, Dennis Krämer and Andrei
Barascu from DECHEMA!!



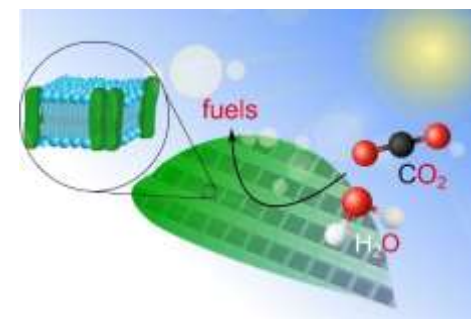
Artificial Photosynthesis – State of the Art and Requirements

- Production of appropriate **chemical potentials**
- **Efficient** exploitation of the sun light with **tandems**
- Spatial transport of photo-induced excitation (high mobility, low/**no losses**)
- **Charge carrier separation**: transformation of chemical energy
- **High catalytic activity** - sufficiently low overpotentials
- High photochemical **stability**: corrosion-resistant and/or surface passivation
- **Competitive costs**

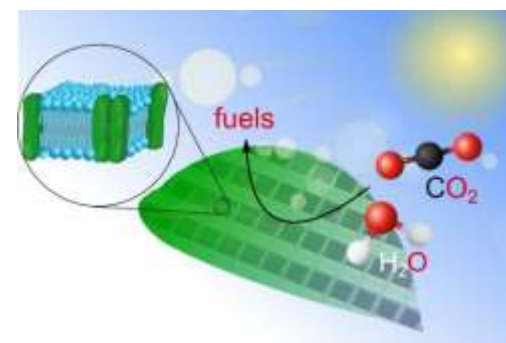


Artificial Photosynthesis – outlook?

- Could become a disruptive method to produce clean fuels
- Progress has been made, but it is still fundamental research
- Needs ongoing long term research efforts to be successful
- Complementary expertise at different sites in the United States and Germany
- Could provide the critical mass needed to accelerate research
- **We aim to intensify our collaboration in the field of Artificial Photosynthesis. This new US-German workshop series, including scientists and funding agencies, will identify innovation bottlenecks and discuss common research interests to stimulate collaborations.**

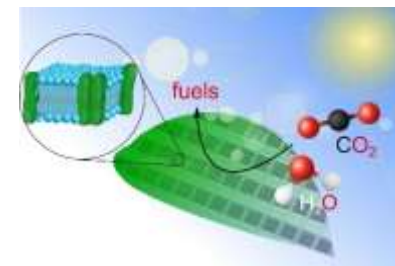


Challenges



- Knowledge gaps to transition to a technology: efficiency, low cost materials, long-term stability
- Challenges span atomic to macroscopic scale
- Science breakthroughs needed in catalysis, light harvesting, charge transfer, integration
- Multidisciplinary approach using nanotechnology, photochemistry, photophysics, synthetic biology, device engineering
- Need cutting edge tools, long term support of researchers and facilities

Charge to 2020 workshop



Provide a strong foundation for future U.S.-German collaborations that will accelerate progress in Artificial Photosynthesis research

- Develop a common understanding of challenges, knowledge and appreciation of expertise and capabilities
- Identify mechanisms to encourage and enable collaborations
- Focus on challenges associated with design of integrated systems and prototypes
- Identify scientific research framework, priority areas of fundamental research for collaborative work
- Identify expertise and capabilities currently available, and those needed to make progress
- Consider fundamental research needs to underpin the research framework
- Consider strategies to achieve efficiency and stability required to transition from research to technology development phase

Research themes from the workshop

1. Design and demonstration of efficient and durable solar fuels systems
2. Use of biological concepts
3. Approaching theoretical efficiency
4. Scale-up toward demonstration
5. Crosscutting scientific opportunities

Design and demonstration of efficient and durable solar fuels systems

- Standardization of cells, systems
- Establishment of benchmarks
- Reproducibility standards and measurement protocols
- Longer term:
 - Joint user facilities
 - Shared databases
 - Standard models
 - Machine learning platforms

Use of biological concepts

- Bio-mimetic systems
- Incorporation of concepts of feedback and adaptivity
- Exploration of biodiversity and modularity as new paradigms

Approaching theoretical efficiency

- Pivotal to development of a viable technology
- Identification and integration of semiconductor materials systems
- Artificial leaf structures with selective oxidation and reduction chemistry
- Full coupling of anodic and cathodic processes with minimal losses

Scale-up toward demonstration

- Near term: Supplies crucial information on materials and needed engineering innovations
- Medium term: development to higher TRL (6+)
- Long term: lifecycle assessments and technoeconomic evaluations



Crosscutting scientific opportunities

- Establishment of relevant model systems to deepen understanding of
 - Charge carrier dynamics
 - Catalysis
 - Photocorrosion
 - Operando characterization

Recommended followup

- Meetings series to build collaborations
 - Frequent virtual workshops before and after travel is possible to discuss progress
 - In-person in-depth meetings to refine strategy and identify new opportunities
- Refine priority areas for cooperations
 - Demonstrators
 - Benchmarking facilities
 - Operando characterization
 - Theory and modeling



Future plans

Next workshop meetings:

June 29th, chaired by Shane Ardo & Wolfram Jaegermann

Tentative theme: "*Absorber structures and involved conversion processes: Perspectives and limitations*"

July 27th or **August 3rd**, chairs TBD

... formats will emphasize debate and discussions



Today's format

- Talk by Harry Atwater
- 5 minute break
- Talk by Wolfram Jaegermann
- 30 minute discussion

***Please put questions **in the Q&A**
as you think of them!!!***

Please feel free to address them to a speaker