CAMBRIDGE ZERO $_2$

Light Harvesting
Special Interest Group

Sunlight to Chemical Conversion – Devices and Applications, 4th May 2022

Panel

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Challenges

- Stability. PVs as light absorbers in water.
- Scalability. Chemical production and collection on large surface areas.
- Efficient and clean solar to chemical conversion.
- Intermittency. Seasonal availability of sunlight.
- Replacing fossil fuels in chemical industries.
- Product separation. Separation of liquid products from solution requires energy.
- Storage and transportation of gaseous products (e.g., green H2).

Discussion Points

- Direct solar to chemical synthesis; how important is it?
- Solar-driven chemical production is an exciting area of research, often inspired by natural photosynthesis.
- Chemicals and materials can be made from solar energy and CO_2.
- Green H_2 production and storage could serve as an alternative to large-scale battery storage.
- Solar energy is abundant and free. Photovoltaics (PVs) coupled to electrolysis already allow for green H_2 generation, as well as synthesis of alcohols.
- Powering our future has large renewable energy requirements. Solar power and wind power are key options.
- Dark hydrogenation of CO_2 can be done using solar-derived H_2 from water, as well as by direct solar CO_2 utilisation. Gas phase hydrogenation of CO_2 (e.g. methanol transformation) requires high pressure and temperature.
- In solar to H_2, transport of H_2 is a challenge that needs to be addressed.
- A further challenge to address is improving the oxygen evolution reaction and investigating alternative scalable oxidation reactions.
- Chemicals other than H_2 are also important, where clean production and value creation needs to be taken into account. E.g., microorganisms can produce isopropanol, which is now important due to COVID-19 and can also be used as a fuel.
- Chemical industries mostly rely on fossil fuels to make cheap commodity chemicals from CO_2 and H_2. For e.g., ethylene is an important building block that can make other important products. Cascade reactions is an attractive catalysis approach to generate high-value products.
- The market value of different products should be taken into consideration to help estimate profits.
- Integrating technology with existing local infrastructure will require support by government and policy makers.
- Decentralisation can strengthen solar fuels research.
- Microorganisms can be used to produce chemicals locally.
- Chemical safety must be taken into account locally for local solar fuel production.

Opportunities

- PV-electrolysers are being developed for commercial use.
- Early-stage technology is ripe for stronger interaction with industry to take to next stages.
- Extensive research is ongoing to develop robust and scalable solar to chemical conversion devices.
- Fast progress in developing catalysts to make clean fuels.
- Work with government and industry to bring solar fuels to the market.

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