Solar-driven Synthesis of Fuels and Chemicals from Biomass and Plastic Waste

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Abstract:
Artificial photosynthesis is a sustainable process that utilises solar energy to drive endothermic multi-electron chemical reactions for the production of fuels. A common drawback in photoelectrochemical systems is their reliance on expensive materials and device architectures, which challenges the development of ultimately scalable devices. Particulate photocatalysts provide a potentially lower-cost alternative, but their low efficiencies and common reliance on costly sacrificial redox reagents limit their commercial prospects.

This presentation will give an overview about our recent progress in developing semiconductor suspension systems to perform efficient full redox cycle solar catalysis using inexpensive components, and our approach for sustainable photo-reforming of waste biomass and plastics (Figure 1). The principles and design considerations for the solar-driven photo-reforming process will be compared to traditional artificial photosynthetic systems and benefits and disadvantages discussed.

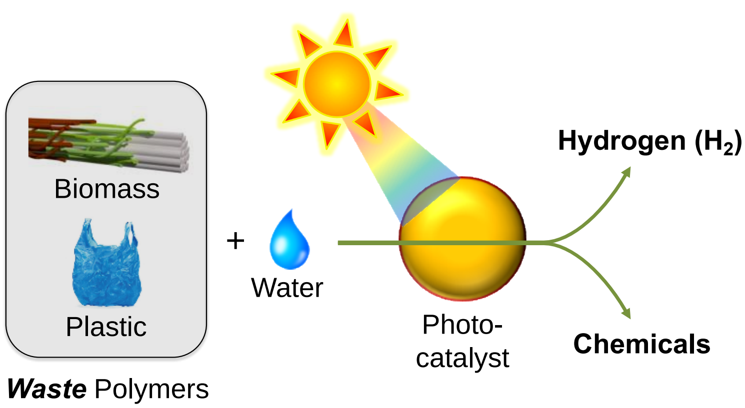

Figure 1. Solar-driven reforming enables the conversion of waste biomass and plastics into H_2 fuel and bulk chemicals.

Specifically, CdS/CdO_x quantum dots and carbon-based materials such as carbon nitride have been recently established as suitable photocatalysts for the photo-conversion of lignocellulosic biomass and synthetic polymers such as polyethylene terephthalate (PET) and polylactic acid (PLA) in aqueous medium into H_2 fuel and organic chemicals (in particular organic acids and monomeric building blocks of the polymer substrate).[1-5] Thus, this ambient-temperature photo-reforming process offers a simple and low-energy means for transforming polymeric waste into fuel and bulk chemicals.

Representative Publications

(1) Uekert, Kasap, **Reisner**. Photoreforming of Nonrecyclable Plastic Waste over a Carbon Nitride/Nickel Phosphide Catalyst. *J. Am. Chem. Soc*., **2019**, *141*, 15201.

(2) Kasap, Achilleos, Huang, **Reisner**. Photoreforming of Lignocellulose into H2 Using Nanoengineered Carbon Nitride under Benign Conditions. *J. Am. Chem. Soc*., **2018**, *140*, 11604.

(3) Uekert, Kuehnel, Wakerley, **Reisner.** Plastic Waste as a Feedstock for Solar-driven H2 Generation. *Energy Environ. Sci*., **2018**, *11*, 2853.

(4) Kuehnel, **Reisner**, Angew. Solar Hydrogen Generation from Lignocellulose. *Chem. Int. Ed*., **2018**, *57*, 3290.

(5) Wakerley, Kuehnel, Orchard, Ly, Rosser, **Reisner**. Solar-driven Reforming of Lignocellulose to H22 with a CdS/CdOxx Photocatalyst. *Nature Energy*, **2017**, 2, 17021.

Biography:

Erwin Reisner received his education and professional training at the University of Vienna (PhD in 2005 and Habilitation in 2010), the Massachusetts Institute of Technology (postdoc from 2005-2007) and the University of Oxford (postdoc from 2008-2009). He joined the University of Cambridge as a University Lecturer in the Department of Chemistry and as a Fellow of St. John's College in 2010. He became the head of the Christian Doppler Laboratory for Sustainable SynGas Chemistry in 2012, was appointed to Reader in 2015, and his current position as Professor of Energy and Sustainability in 2017. His laboratory explores the interface of chemical biology, synthetic chemistry, materials science, and engineering relevant to the development of solar-driven processes for the sustainable synthesis of fuels and chemicals. He acts as the Principal Investigator of the Cambridge Centre for Circular Economy Approaches to Eliminate Plastic Waste and Director of the UK Solar Fuels Network, where he promotes and coordinates the national activities in artificial photosynthesis.

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