Extended Abstract

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Artificial photosynthesis for solar fuels: A clean pathway from sunlight to chemical fuels

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Abstract:

Artificial photosynthesis as a route to solar fuels from CO2 and water represents a promising strategy to deliver H2, syngas and hydrocarbons as sustainable feed stocks to support global energy needs and security, and (albeit to a limited extent) mitigate anthropogenic climate change. We have been working on design and synthesis of nanostructured-based materials like TiO2, Cu2O, g-C3N4, layer double hydroxides and halide perovskites for photo catalytic and photo electrocatalytic water splitting and CO2 reduction. In particular, heterojunction-based materials involving visible light absorbing semiconductor and other semiconductors and/or metal nanoparticles greatly enhances interfacial contact between both components relative to their bulk counterparts. The resulting synergic interaction confers a significant improvement in photo induced charge carrier separation, and concomitant aqueous or gas phase CO2 photo catalytic reduction, in the absence of a sacrificial whole acceptor. Our recent highlights on nanoparticle based photo catalysts design and synthesis for water splitting and selective photo catalytic CO2 conversion to reusable low carbon-based products as sustainable feedstock will be discussed. This contribution was presented as the closing lecture at the Faraday Discussion 155 on artificial photosynthesis, held in Edinburgh Scotland, September 5-7 2011. The world needs new, environmentally friendly and renewable fuels to exchange for fossil fuels. The fuel must be made from cheap and "endless" resources that are available everywhere. The new research area of solar fuels aims to meet this demand. This paper discusses why we need a solar fuel and why electricity is not enough; it proposes solar energy as the major renewable energy source to feed from. The scientific field concerning artificial photosynthesis expands rapidly and most of the different scientific visions for solar fuels are briefly overviewed. Research strategies and the development of artificial photosynthesis research to produce solar fuels are overviewed. Some conceptual aspects of research for artificial photosynthesis are discussed in closer detail. On the path to an energy transition away from fossil fuels to sustainable sources, the European Union is for the moment keeping pace with the objectives of the Strategic Energy Technology-Plan. For this trend to continue after 2020, scientific breakthroughs must be achieved. One main objective is to produce solar fuels from solar energy and water in direct processes to accomplish the efficient storage of solar energy in a chemical form. This is a grand scientific challenge. One important approach to achieve this goal is Artificial Photosynthesis. The European Energy Research Alliance has launched the Joint Programmed "Advanced Materials & Processes for Energy Applications" (AMPEA) to foster the role of basic science in Future Emerging Technologies. European researchers in artificial photosynthesis recently met at an AMPEA organized workshop to define common research strategies and milestones for the future. Through this work artificial photosynthesis became the first energy research sub-field to be organized into what is designated "an Application" within AMPEA. The ambition is to drive and accelerate solar fuels research into a powerful European field – in a shorter time and with a broader scope than possible for individual or national initiatives. Within AMPEA the Application Artificial Photosynthesis is inclusive and intended to bring together all European scientists in relevant fields. The goal is to set up a thorough and systematic programme of directed research, which by 2020 will have advanced to a point where commercially viable artificial photosynthetic devices will be under development in partnership with industry.

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