Unconventional water splitting approaches towards scalable solar-hydrogen generators

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Recent economic and environmental factors have propelled an interest towards the development of scalable technologies to increase the share of renewable sources into our energy portfolio. Artificial photosynthesis systems are a promising alternative as they can simultaneously capture and store solar energy in the form of a fuel. Systems based on photoelectrochemical (PEC) cells can take low energy density reactants such as water and/or carbon dioxide and transform them into energy dense hydrogen or carbon containing fuels via light-driven processes. Devices based on PEC cells need to incorporate cost-effective components that can perform the light-absorption, catalytic reactions, ion transport and product separation processes. All of these processes need to take place in parallel, imposing strong interactions and interdependence between all of the components of solar-fuels devices. Furthermore, these interactions require all of the components to operate stably under compatible conditions (i.e. electrolyte composition, pH, irradiation level, temperature). The work presented here tackles the electrolyte compatibility issues in novel water-splitting approaches that perform the ionic transport and gas separation tasks in unconventional ways. The examples discussed here range from the operation of scalable devices under near-neutral buffered electrolytes; the incorporation of fluidic approaches that allow electrolysis devices to produce nearly-pure gases without the need of a separation membrane; and the fabrication of microstructured electrolyzers that produce hydrogen directly from humid air. The integration of light-absorbers into these water-splitting devices will also be discussed.

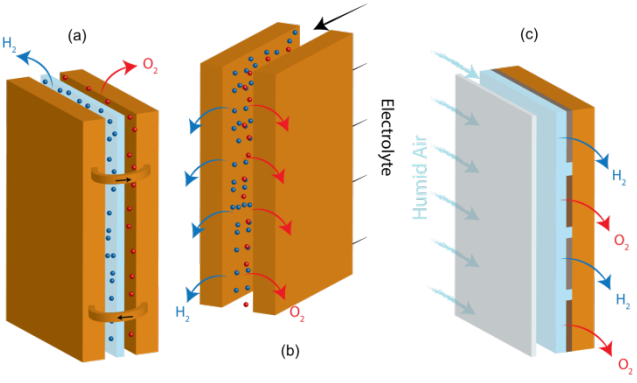

Figure 1. Device morphologies that can operate (a) under buffered electrolytes, (b) without the implementation of a membrane, or (c) directly from humid air.

Brief biography:

Miguel A. Modestino is currently a post-doctoral fellow and project manager of the Nanotera-SHINE project at EPFL (shine.epfl.ch), which aims to develop engineering solutions for the fabrication of practical solar-hydrogen generators. Miguel obtained his Ph.D. in Chemical Engineering from the University of California, Berkeley (2013) and his B.S. in Chemical Engineering (2007) and M.S. in Chemical Engineering Practice (2008)

at the Massachusetts Institute of Technology (MIT). His Ph.D. work focused on understanding and developing self-assembly techniques in hybrid materials for solar-fuels applications. While at Berkeley, Miguel was part of the Joint Center for Artificial Photosynthesis (JCAP) between Caltech and Lawrence Berkeley National Lab. His work at JCAP involved the development of membranes with balanced ion conduction and gas permeation and their incorporation into solar-fuel device prototypes. Currently, Miguel's work involves the coordination and integration aspects of the SHINE project, and his research focusses on novel integrated device architectures for scalable solar-fuel generators.