The Orange County Section of the American Chemical Society

March Dinner Meeting

Thursday, March 21, 2019

The Doubletree Club Hotel
7 Hutton Centre Drive, Santa Ana
Phone: 714-751-2400

Social:	5:30PM
Dinner:	6:00PM
Presentation:	7:20PM

New OPVs where Water is the Semiconducting Medium and H^+/OH^- are the Charge Carriers

Shane Ardo, PhD
Assistant Professor of Chemistry, University of California, Irvine, CA, Orange

Reservations

Please email OCACS@sbcglobal.net *ASAP* but no later than **12 noon** on **Tuesday, March 19, 2019**. Indicate if you will be attending the dinner and program or the program only, and list the names of all attendees. Dinner cost is $30 for members and members' significant others; $35 for non-members or those without reservations. Pay in cash or by check at the door, or mail a check in advance to OCACS, P.O. Box 211, Placentia CA 90871. **The first five students who register for a meeting will receive a $10 discount on their dinner.**

There is no charge for attending the program only. However, voluntary donations will be accepted to help defray meeting costs.

Note: OCACS pays the hotel on the basis of the number of dinner reservations made. Your RSVP for dinner is a commitment to pay for dinner. Space may be limited.

Directions

Take the Costa Mesa Freeway (55), exit at MacArthur Blvd. and go west (towards South Coast Plaza). Turn left on to MacArthur Place. The DoubleTree *Club* Hotel is straight ahead on the left. (Do not turn right at MacArthur Place to the DoubleTree Hotel, which is easily mistaken for the DoubleTree Club Hotel.) Park in front of the hotel, or follow the signs. If the parking lot is full, ask the valet staff where to park.

New OPVs where Water is the Semiconducting Medium and H^+/OH^- are the Charge Carriers

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Abstract

Sulfur-Fluorine Most electrochemical technologies that operate under ambient conditions require ion-conducting polymer electrolytes. These polymers are passive in that electric bias drives ion migration in the thermodynamically favored direction. Recently, my group engineered two important features into passive ion-selective polymers to introduce the active function of photovoltaic action and demonstration of an ionic solar cell. These features were covalent bonding of photoacid dyes to the polymers such that absorption of visible light resulted in liberation of protons, and synthesis of polymer membranes with charge-selective contacts to facilitate separation and collection of H+ and OH–. Light excitation from either side of the polymer membranes resulted in H+ dissociation followed by directional charge collection. The charge collection direction was dictated by the electrostatic asymmetry in the polymers, which was formed due to an external pH difference setup across the membrane.

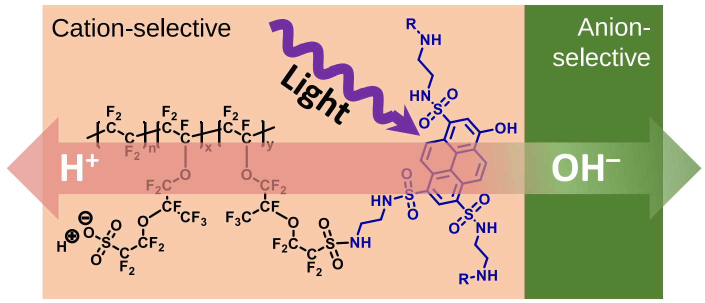

Figure 1. Proposed general structure and overall sensitization process for a photoacid-dye-modified bipolar

Joining a monopolar cation-selective polymer to a monopolar anion-selective polymer forms a bipolar membrane, which mimics a rectifying semiconductor pn-junction diode in form and function (Figure 1), and is able to maintain pH differences across it. Using a photoacid-dye-modified bipolar membrane, we measured a photovoltage of ~120 mV under conditions of solar-simulated excitation. In addition to more traditional electrochemical techniques, insights into materials function were obtained using finite-element numerical modeling of photoacid kinetics and membrane physics; beam-line x-ray scattering measurements; electrochemical impedance, solid-state NMR, and pulsed-laser spectroscopies; and fluorescence, electron, and force microscopies. Collectively, these photo-responsive polymers represent a new class of functional materials that use light to trigger changes in local ion concentration and electrostatic potential. These local changes can be used to affect macroscopic processes such as direct sunlight-driven redox chemistry or desalination of salt water (Figure 2), chemical catalysis, and triggering of cellular processes.

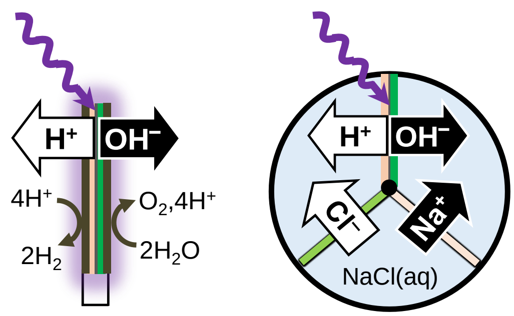

Figure 2. Proposed applications for photoacid-dye-modified bipolar membranes of light-driven redox chemistry and desalination of salt water.

References

(1) Reiter, R. S.; White, W.; Ardo, S. *Journal of The Electrochemical Society*, **2016**, *163*, H3132–H3134. Electrochemical characterization of commercial bipolar membranes under electrolyte conditions relevant to solar fuels technologies.

(2) White, W.; Sanborn, C. D.; Reiter, R. S.; Fabian, D. M.; Ardo, S. *Journal of the American Chemical Society*, **2017**, *139*, 11726–11733. Observation of photovoltaic action from photoacid-modified Nafion due to light-driven ion transport.

(3) White, W.; Sanborn, C. D.; Fabian, D. M.; Ardo, S. *Joule*, **2018**, *2*, 94–109. Conversion of visible light into ionic power using photoacid-dye-sensitized bipolar ion-exchange membranes.

Biography

Shane obtained a B.S. Degree in Mathematics, with a minor in Computer Programming, from Towson University and subsequently worked as a software engineer, community college instructor, and high school teacher prior to attending graduate school. Shane obtained an M.S. Degree in Nutrition from the University of Maryland, College Park followed by M.A. and Ph.D. Degrees in Photo-Physical Inorganic Chemistry from the Johns Hopkins University, where he worked for Prof. Jerry Meyer. He then worked for Prof. Nate Lewis as a DOE-EERE Postdoctoral Research Awardee at the California Institute of Technology until 2013. Since that time, Shane has been an Assistant Professor at the University of California, Irvine in the Department of Chemistry and holds a joint appointment in the Department of Chemical Engineering and Materials Science.

Shane leads the Ardo Group for Molecular-Level Engineering of Functional Materials, which designs, synthesizes, and characterizes molecule–materials hybrids and aims to understand and control reaction mechanisms at asymmetric interfaces with the goal of optimizing energy conversion for practical applications, including solar seawater desalination, solar fuels devices, photovoltaics, fuel cells, and batteries.

In 2016, Shane was named one of five inaugural Moore Inventor Fellows. He is also a recipient of a DOE Early Career Research Award and a Beall Innovation Award, and was named a Sloan Research Fellow, a Cottrell Scholar, a Kavli Fellow, and a Scialog Fellow. Shane has given over 100 invited talks, including at the National Academy of Sciences Distinctive Voices Lecture Series, the 2017 Resnick Institute Young Investigators Symposium, and Apple's Membrane R&D Division. His research group is also supported by funding from the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, the U.S. National Science Foundation's Chemical Catalysis Program, Nissan Chemical Industries Ltd., and collaborative projects funded by University of California MEXUS–CONACYT and Research Corporation for Science Advancement.