CCST PRESENTS EASTMAN SEMINAR SERIES

Ph.D., University of Delaware, 2012

Daniel Esposito

Columbia University

Date: Thursday, March 23, 2017
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Location: 366 Colburn Lab

New time

Daniel Esposito received his Ph.D. in Chemical Engineering at the University of Delaware and studied as a postdoctoral research associate at the National Institute of Standards and Technology (NIST) under a National Research Council fellowship. He is now an Assistant Professor in Chemical Engineering at Columbia University, where his group's research interests relate broadly to solar and electrochemical technologies. Specific topics of interest including electrocatalysis, photoelectrochemistry, 3D printing for electrochemical engineering, and the use of advanced in situ analytical tools for studying (photo)electrocatalytic materials at high spatial and/or temporal resolution. At Columbia, his research group combines its core expertise in electrochemical and catalytic sciences with core Chemical Engineering principles to develop innovative electrochemical and solar energy conversion technologies.

Hydrogen Production from Water Electrolysis— With and Without Membranes

This talk is motivated by the idea of a sustainable energy future in which hydrogen (H_2) fuel is produced from water electrolysis powered by solar or wind energy. If such a future is to be realized, improvements in the efficiency, durability, and cost of electrocatalytic materials and devices must be achieved. In the first part of this talk, I will describe simple and scalable membraneless electrolyzers that offer exciting opportunities to decrease the capital costs of electrolyzers. Conventional polymer electrolyte membrane (PEM) electrolyzers rely on membranes to conduct H^+ ions between electrodes while separating the H_2 and O_2 product species, but these membranes can be costly, susceptible to failure, limit allowable chemistries, and require a fairly complex architecture. Recently, our group has demonstrated 3D printed membraneless electrolyzers in which the aqueous electrolyte is actively pumped through angled mesh flow-through electrodes to separate the H_2 and O_2 product gases with minimal product crossover.[1] After describing the operation of these flow cells, I will introduce "flow-free" membraneless electrolyzers and integrated photovoltaic-electrolysis devices that can operate without a pump and thereby enable further simplification. The second part of this talk will re-introduce membranes for water electrolysis, but place them in a completely different location. In this project, we investigate novel electrocatalyst architectures based on Pt nanoparticles and thin films that are encapsulated by ultra-thin silicon oxide layers.[2] We show that these oxide overlayers can serve as "nanomembranes" that are selectively permeable to certain electroactive species and thereby enable efficient and selective electrocatalysis at the metal oxide / metal interface. By systematically varying the thickness of the oxide overlayer, we explore its transport properties and influence on the performance of thin film hydrogen evolution electrocatalysts. These results highlight the potential for the MCEC design to be tunable platform for stable and selective electrocatalysis.

References

[1] G.D. O'Neil, C. Christian, D.E. Brown, D.V. Esposito, Journal of the Electrochemical Society, 162, F3012-F3019, 2016.
[2] N. Y. Labrador, X. Li, Y. Liu, J. T. Koberstein, R. Wang, H. Tan, T. P. Moffat, and D. V. Esposito, Nano Letters, vol. 16, 6452-6459, 2016.