A NanoBioLab Symposium 2021 Webinar

Prof. Bruce Dunn, University of California, Los Angeles

NEW DIRECTIONS IN MATERIALS AND STRUCTURES FOR ELECTROCHEMICAL ENERGY STORAGE

Friday, March 19, 2021
9:00 - 10:00 am SGT
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Meeting ID: 948 0786 5705
Passcode: 489734

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ABSTRACT

This presentation will have two distinct but related sections. The first topic to be discussed will be ionogels. These are pseudo-solid state electrolytes in which an ionic liquid electrolyte is confined in a mesoporous inorganic matrix. The resulting material possesses the electrochemical, ion transport and thermal properties of the ionic liquid despite being a macroscopic solid. Because of their unique architecture, ionogels maintain a nanoscale fluidic state and thus mitigate the interfacial resistances which commonly arise at solid-solid interfaces. The use of sol-gel synthesis enables the materials to be prepared as liquids and to penetrate porous electrodes before becoming solid, an especially beneficial property for solid-state batteries. Our recent work on both Li^+ and Na^+ conducting ionogels will be presented.

The second part of the presentation will cover the integration of ionogels in non-planar solid-state battery configurations. In this work, we developed a platform that not only demonstrates the benefit of a 3D array electrode geometry but also enables easier fabrication using established materials and processes. Specifically, we constructed a solid-state 2.5D battery consisting of a 3D $LiFePO_4$ (LFP) post array and a planar, Li anode separated by the ionogel electrolyte. The ability to process the ionogel as a liquid, which then gels to a macroscopic solid phase while maintaining the liquid-like behavior at the nanoscale, satisfies the conformality and wetting issues often required for complex electrode architectures. This 2.5D battery offers high areal energy densities from the post array while the high conductivity ionogel solid electrolyte enables high power densities. The energy and power density values obtained for the 2.5D solid-state microbattery exceed those of any 3D solid-state system.

ABOUT THE SPEAKER

Bruce Dunn is the Nippon Sheet Glass Professor of Materials Science and Engineering at UCLA. Prior to joining UCLA, he was a staff scientist at the General Electric Research and Development Center. His research interests concern the synthesis of inorganic and organic/inorganic materials, and the characterization of their electrical, optical, biological and electrochemical properties. His recent work on electrochemical energy storage includes three-dimensional batteries and pseudocapacitive materials. Among the honors he has received are a Fulbright research fellowship, the Orton Lectureship from the American Ceramic Society, awards from the Department of Energy for outstanding research in materials science and invited professorships in France, Japan and Singapore. He is a Fellow of the American Ceramic Society, the Materials Research Society and a member of the World Academy of Ceramics. In addition to serving on the Board of Reviewing Editors at Science, he is a member of the editorial boards of Advanced Energy Materials, Solid State Ionics, Advanced Electronic Materials, Energy Storage Materials and Journal of the American Ceramic Society.

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