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Organic-Based Aqueous Flow Batteries for Massive Electrical Energy Storage

Wednesday
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320 Shillman Hall
11:45 a.m. – 1:00 p.m.

Refreshments will be served

ABSTRACT The ability to store large amounts of electrical energy is of increasing importance with the growing fraction of electricity generation from intermittent renewable sources such as wind and solar. Solid-electrode batteries are drained far too soon, when discharged at full power, to economically fill the gaps in photovoltaic or wind temporal power profiles. Flow batteries show promise because the designer can independently scale the power (electrode area) and energy (arbitrarily large storage volume) components of the system by maintaining all electro-active species in fluids. Wide-scale utilization of flow batteries is limited by the abundance and cost of these materials, particularly those utilizing redox-active metals and precious metal electrocatalysts. We have developed a flow battery based on the aqueous redox chemistry of small organic molecules called quinones. The redox active materials contain no metals and can be very inexpensive. Electrochemical studies show that these molecules undergo fast and reversible two-electron two-proton reduction on carbon electrodes without the addition of electrocatalyst. An aqueous flow battery involving the quinone/hydroquinone couple has achieved a peak power density exceeding 0.6 W/cm^2 and has undergone over 100 deep discharge cycles with 99.986% capacity retention per cycle. The absence of active metal components in both redox chemistry and catalysis represents a significant shift away from the direction modern battery R&D has been taking. This new approach may enable massive electrical energy storage at greatly reduced cost.

BIOGRAPHY Michael J. Aziz received a Ph.D. in Applied Physics from Harvard in 1983. He has been a member of the faculty at what is now the Harvard School of Engineering and Applied Sciences since he joined in 1986 and is now Gene and Tracy Sykes Professor of Materials and Energy Technologies. Aziz has made significant contributions to a number of fields in applied physics and materials science. He is a Fellow of the American Physical Society, the American Association for the Advancement of Science, and the Materials Research Society. Among his research interests are novel materials and processes for energy technology and greenhouse gas mitigation. He is the Faculty Coordinator for Harvard's University-Wide Graduate Consortium on Energy and Environment, for which he developed a quantitative course on Energy Technology for a group of students in diverse disciplines. He is co-authoring a textbook, "Introduction to Energy Technology: Depletable and Renewable", to be published by Wiley-VCH.

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