Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **2130** Type: **Oral (Graduate Student) / Orale (Étudiant(e) du 2e ou 3e cycle)**

Organic electrolytes for use in low-cost aqueous redox flow batteries (G)

Wednesday, 13 June 2018 16:30 (15 minutes)

Redox flow batteries are a promising solution for large-scale energy storage. Many flow batteries have been successfully commercialized; however, these systems typically involve the use of expensive metallic redox couples such as vanadium, iron-vanadium and iron-chromium, which exceed the US Department of Energy's cost target of $100 kWh-1.

One approach to reducing systems costs involves the application of organic redox couples, which can be synthesized from abundant low-cost materials. An additional benefit of organic materials is that their reaction kinetics and material properties (such as solubility, number of redox states, and reduction potential) can be adjusted through changes in synthetic design. Quinones are a family of organic materials with well-studied electrochemical properties [1,2]. Owing to their electrochemical reversibility tunable reduction potential and solubility, quinones have recently been demonstrated as an effective class of redox couples in aqueous organic flow batteries [3,4].

This project investigates the use of a commercially available quinone dye –3,4-dihydroxy-9,10-anthraquinone-2-sulfonate sodium (alizarin red S.) –as a negative electrolyte in an alkaline redox flow battery. Paired with potassium ferrocyanide, the system demonstrates a nominal operating voltage of 1.1 V, when cycled at 50 mA (10mA/cm2). Using these cycling conditions under a blanket of flowing argon, the system is shown to exhibit a stable coulombic efficiency of ˜90% and voltage efficiency of ˜60% for over 50 cycles before irreversible capacity fade begins to occur. The development, design and results for this aqueous flow battery system will be presented.

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Session Classification: W4-1 Energy Storage 4 (DCMMP) | Accumulation d'énergie 4 (DPMCM)

Track Classification: Condensed Matter and Materials Physics / Physique de la matière condensée et matériaux (DCMMP-DPMCM)