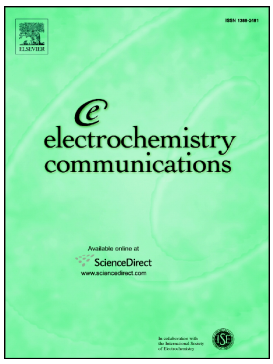

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Direct visualization of reactant transport in forced convection electrochemical cells and its application to Redox Flow Batteries

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Abstract

A novel, simple and low cost electrochemiluminescence imaging method for monitoring mass transport phenomena in a redox flow battery-like system is presented. Luminol solutions were pumped through a flow field (FF) with a given design. At the flowfield/electrode interface light is emitted upon dye oxidation allowing direct visualisation of channels, U-bends and regions of poor wetting. Image analysis allows direct visualisation of reactant distribution and poor mass transport through tortuous materials. These results were compared with the experimental performance of an all-vanadium redox flow battery with different FFs as a function of flow and good correlation achieved.

1.0 Introduction

Redox Flow Batteries (RFB) are one of the most promising systems for medium to large scale energy storage due to its versatility and fast response.[1] Despite recent efforts in improving cell design,[2-4] electrode kinetics[5-7] and energy density;[8] the widespread implementation of RFBs is hindered by high capital cost. Higher electrolyte utilisation – in terms of improved state of ultimate charge (SoC) and increased local reaction rates (leading to lower stoichiometries at constant flow) - would be advantageous to improve energy density and round trip efficiency. This could be achieved with a better understanding of mass transport processes within the RFB which have traditionally been studied using mathematical models