

Diagnostics of All-Vanadium Flow Batteries Through an *In-Situ* Local Potential Distribution Measurement Technique

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With the potential of high energy efficiency and long cycle life time in deep charge/discharge, redox flow batteries (RFBs) hold promise for storing energy from renewable sources and application for smart grid and stand-alone power systems¹. Various types of RFBs have been developed based on different chemistry. One of the most promising RFBs is the all-vanadium flow battery (VRB) as developed by Skylas-Kazacos and coworkers². The same element in solution of acid with different oxidation states is used. Prior research was mainly focused on the development of better material for VRBs such as ionic exchange membranes and porous carbon electrode materials³. The motivation of this work is to develop a diagnostic tool to monitor through plane current and electrolyte distribution of a RFB.

In this work, we report for the first time on our groups' ongoing research an *in-situ* local potential measurement method, as a diagnostic tool to determine the potential distribution within a RFB system (VRB as an exemplified system). Micro potential probes were prepared with Pt materials and the *in-situ* measurement of local redox potentials were recorded by inserting these micro potential probes between multiple layers of porous carbon paper electrode. The potential profile normalized to the surface of the flow plate was also determined. This method can be carried out under any operating condition of a RFB cell such as charging-discharging process and OCP state with almost no interruption.

It is found that the distribution of potentials in the through plane direction (perpendicular to the flow plate) is uniform at the positive side under the condition of open-circuit voltage (OCV). However, when the single cell was discharged with constant current density, the

potential distribution becomes non-homogeneous. The potential value in an area closed to the flow plate (FP) is lower than that close to the membrane side, which suggests that the reaction location is towards the FP side. The reaction location is compressed and shifted from the membrane side to the FP side with an increase in the discharging current density. Consequently, the electrode area utilization suffers at higher discharge currents.

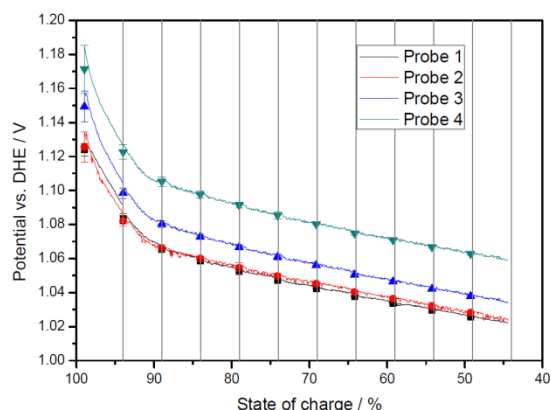


Figure 1. Effect of state of charge on the potentials at different location inside in the positive electrode for a vanadium flow battery.

References

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