Comparing Symmetric and Asymmetric Electrochemical Capacitors: A Modeling Approach

John A. Staser[a] and John W. Weidner[b]

[a]Center for Electrochemical Engineering Research
Department of Chemical and Biomolecular Engineering
Ohio University
Athens, OH 45701

[b]Center for Electrochemical Engineering
Department of Chemical Engineering
University of South Carolina
Columbia, SC 29208

Current trends indicate that renewable energy will make up a larger portion of our overall energy portfolio over the coming decades. Energy storage represents one of the major challenges to more widespread adoption of renewable energy. Electrochemical capacitors provide an opportunity for load leveling for energy storage.

Traditional electrochemical capacitors rely on double-layer charging; they typically consist of two identical electrodes separated by an electrolyte. Often, these identical electrodes are porous carbon.

Asymmetric capacitors consist of two dissimilar electrodes; the two electrodes are often a porous carbon electrode and a battery-type electrode. The advantage of asymmetrical capacitors is the higher energy and power density due to the non-identical potential changes in the two electrodes.

We have developed mathematical models comparing operation of symmetric and asymmetric capacitors. A schematic of the two systems is shown in **Figure 1**.

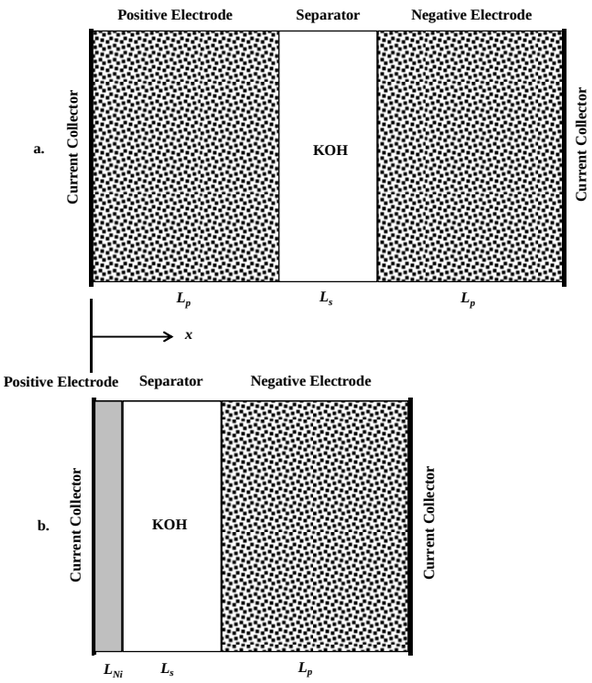

Figure 1. Schematic comparing symmetric (top) and asymmetric (bottom) capacitors.

The non-identical potential changes in the two electrodes of the asymmetric capacitor lead to longer discharge times compared to symmetric capacitors, as shown in **Figure 2**.

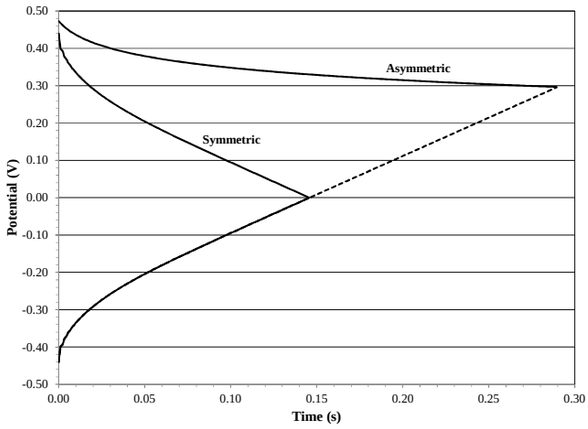

Figure 2. Comparison of the discharge curves for asymmetric and symmetric capacitors.

The longer discharge times and non-identical discharge profiles result in higher energy and power densities for asymmetric capacitors.

This talk will focus on the development of the mathematical model comparing symmetric and asymmetric capacitors and the difference in operation of the two systems.