Effect of carbon additives on the microstructure and conductivity of primary alkaline battery cathodes

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The goal of this work is to investigate the transport efficiency of conductive carbon additives in primary alkaline battery cathodes that contain electrolytic manganese dioxide (EMD). This works attempts to relate the underlying carbon additive material properties and cathode microstructure to overall battery performance, enabling optimization of electrode design. Specifically, a combination of carbon additives with different morphologies may be used to produce a battery with better performance through more effective microstructural pathways for electrons and ions [1].

This work expands upon our group's previously developed analytical techniques including FIB/SEM imaging, transport property measurements, and 3D microstructure modeling [2-4]. One emphasis of this work is the impact of the electrolyte on electronic conductivity. Figure 1 shows preliminary data comparing electronic conductivity for EMD-based cathodes with and without electrolyte, namely "wet" and "dry." These data indicate that for EMD-based cathodes, with TIMCAL BNB90 carbon additive, that the presence of 8.7-M KOH electrolyte significantly improves electronic conductivity. This improved performance can be cursorily related to the respective wet and dry microstructures. Figure 2 compares SEM/FIB images for wet and dry cathode microstructures. These preliminary images suggest that the enhanced wet conductivity is due to the electrolyte improving interfacial contacts.

We will present the results of the following work: (1) development of experimental apparatuses to measure electronic transport or conductivity with and without electrolyte, (2) analysis of experimental results and FIB/SEM images for various carbon additive under different conditions such as with and without electrolyte, under pressure and with pressure removed, and at various porosities, and (3) development of a preliminary 3D stochastic model to imitate microstructure corresponding to different carbon additives in EMD-based cathodes.

References:
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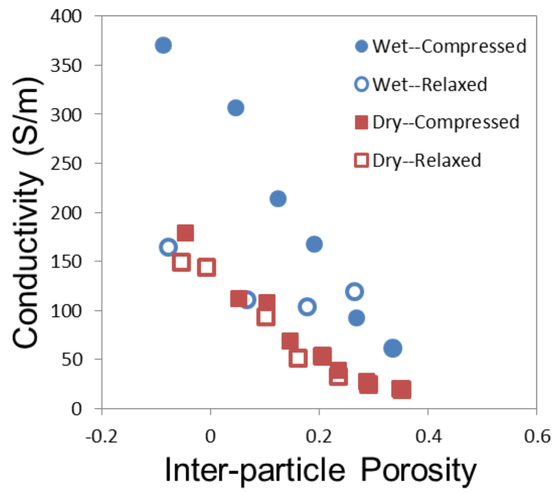

Figure 1: Comparison of wet and dry electronic conductivity vs. inter-particle porosity for TIMCAL BNB90-based cathodes.

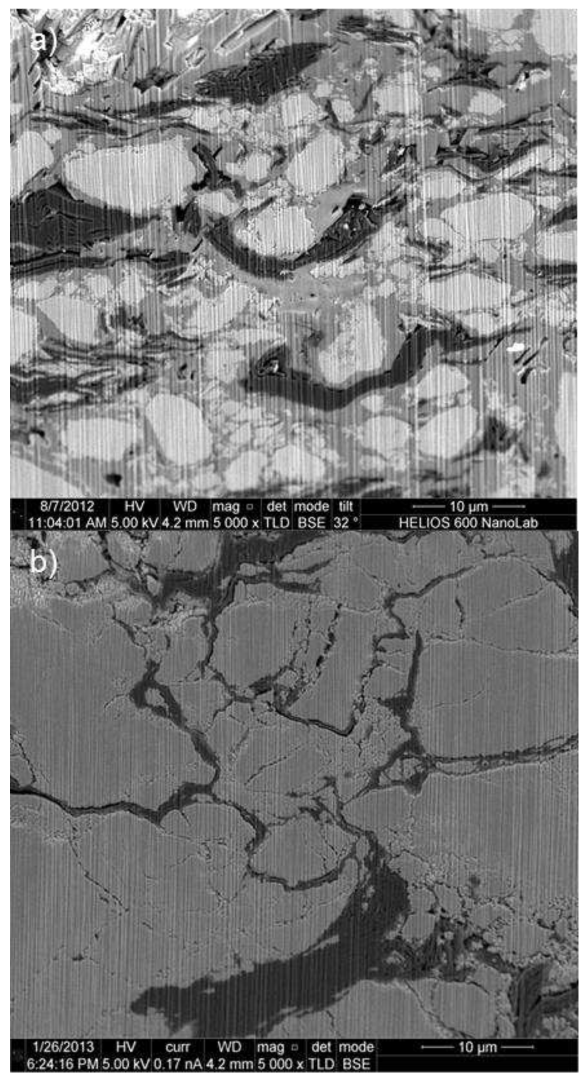

Figure 2: Preliminary comparison of wet and dry cathode microstructures: (a) wet microstructure is from a commercial alkaline C-cell, and (b) dry EMD/BNB90 cathode. In these images, light gray is EMD, black is carbon, and dark gray is KOH/pore.