WORKGROUP 2B1: Global Collaboration to Understand The "DCA Memory" Effect

1) GOAL

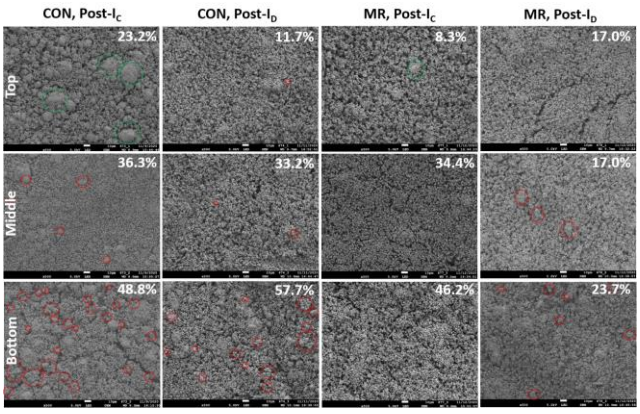
The EN-50342-6 Dynamic Charge Acceptance Test is a well-respected measurement of a battery's chargeability in 3 application-relevant modes: "I_C", chargeability from a subsequent charge; "I_D", chargeability from a subsequent discharge; and "I_R", chargeability in a drive cycle. I_D is always ~4X higher than I_C, suggesting DCH history plays a role in performance. Several global teams sought to falsify the hypothesis that this "memory" effect was due to Ostwald Ripening.

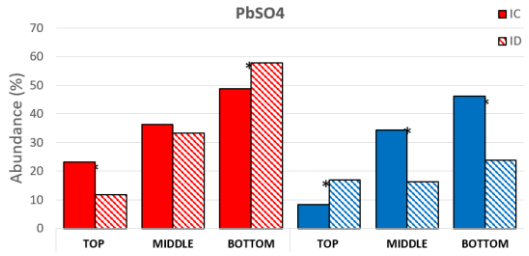
2) METHODS

Labs used their own cell designs and the CBI Best Practices. Acid gravity was set to 1.28 sg. Labs used a modified EN-DCA which included a preamble (2*RC or up to 3*C_{20}) and standard C_{20} DCH (Step #16). The duration of Step 25 was doubled to bring the cell to 80% SoC in I_C and I_D (normally, I_D is run @ 90%). Voltages were reduced 6X due to single-cell nature. NAM was extracted after each DCA_{pp} sequence (I_C / I_D) for materials analysis (Steps #21/27).

3) RESULTS

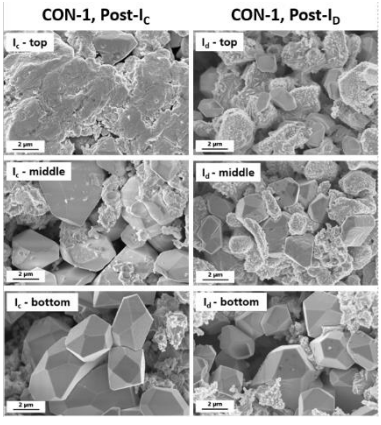
BLACK DIAMOND STRUCTURES, LLC





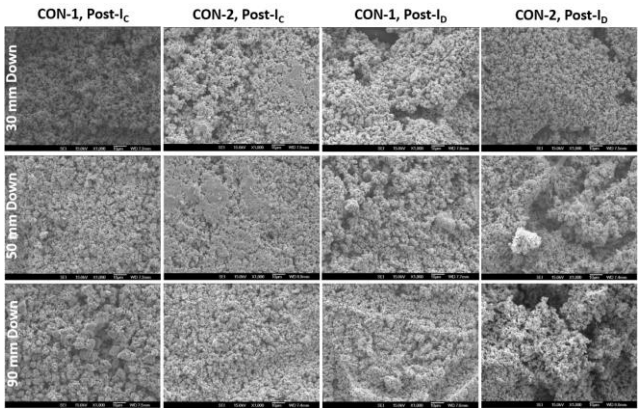
FINDINGS = I_D/I_C ~ 5.5, strong AM stratification ($PbSO_4$ in red circles), crystal clusters post-I_C (green circles), I_D charging focused near tab, Molecular Rebar improved AM consistency after I_D. 500X MAG.

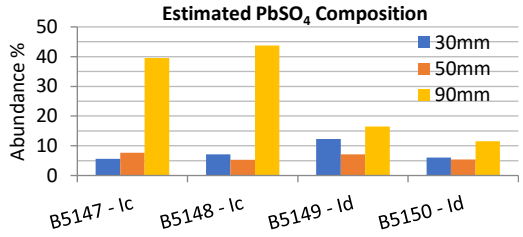
FRAUNHOFER ISC



FINDINGS = I_C showed larger $PbSO_4$ than I_D, bottom had larger crystals than the top, bottom/top difference more pronounced than I_C/I_D.

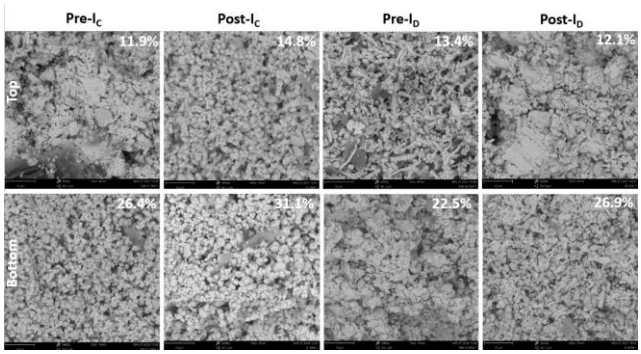
ARCACTIVE, LTD





FINDINGS = I_D/I_C ~ 3-4 (I_C @80%, I_D @90%), reference electrode indicated negative electrode limited, strong AM stratification especially post-I_C ($PbSO_4$ is larger, more obvious lower on the plate). 1000X MAG

EAST PENN MANUFACTURING



FINDINGS = Strong AM stratification in I_C and I_D, I_C is stratified the most, images corroborate XRD. MIP open to interpretation.

4) CONCLUSION

Ostwald ripening as the mechanism behind the DCA Memory Effect was unable to be quantitatively proven or disproven due to limitations in our techniques (only SEM, XRD, MIP) and failures identified in the DCA test itself.

The DCA instigates pronounced SG and AM stratification leading into the DCApp measurement which diminishes potential results 4X and leads to higher abundance and size of $PbSO_4$ at the bottom of the plate. Full recharge prior to ID eliminates stratification and $PbSO_4$ buildup, improving chargeability.

Alternative techniques and sub-surface analysis are required to pursue further.

Talking Points	
	1. *AM/H_2SO_4 stratification: cause or correlation of Memory?*
	2. *Was this a worthy experiment – Learnings? Continuation?*
	3. *Stratification artificially lowered the heaviest weighted I_x?*
	4. *DCA better on a shaking table / in the field? An artefact?*
	5. *New techniques: Internal vs. external SEM and XRD?*