Battery Cell Durability within a Pack

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Problem Statement

In many current applications, batteries are replaced/recycled at various points in their life. As more multi-cell applications emerge in the grid and transportation sectors this will become a problem due to the high volume of cells in these packs. Some methods will need to be developed to understand the relative health of the individual cells in those packs in order that sustainable decisions can be made around cell replacement and pack replacement. Many issues are currently under debate such as the need for cell matching when replacing cells with in a pack, or overall cell capacity, or even matching numbers of cycles.

Our work is to start to understand the system level issues around cell replacement over time, starting with the fundamentals of individual cell cycling and moving to small packs where small-scale testing and analysis can be done.

Advanced Battery Research

Fundamental and applied studies of batteries for automotive & stationary applications

Supports research & development needs of industrial and national lab partners

Needs identified by battery manufacturers, automotive OEMs, and national labs thru NY BEST :

- **Battery characterization & testing standards/protocols**
- **Battery performance variations**
- **Battery manufacturing impact**
- **Secondary battery use**

RIT in-house research:

- **Failure mode assessment**
- **Post-mortem analysis**
- **Cell balancing and cooling**
- **Advanced charging**
- **Lab-to-field correlation**

Test Plan at a Glance

Initial characterization → Single-cell ageing → Battery-pack studies → Post-mortem analysis

OCV, capacity, impedance, etc.

100, 200, 400 cycles for varying capacity fade

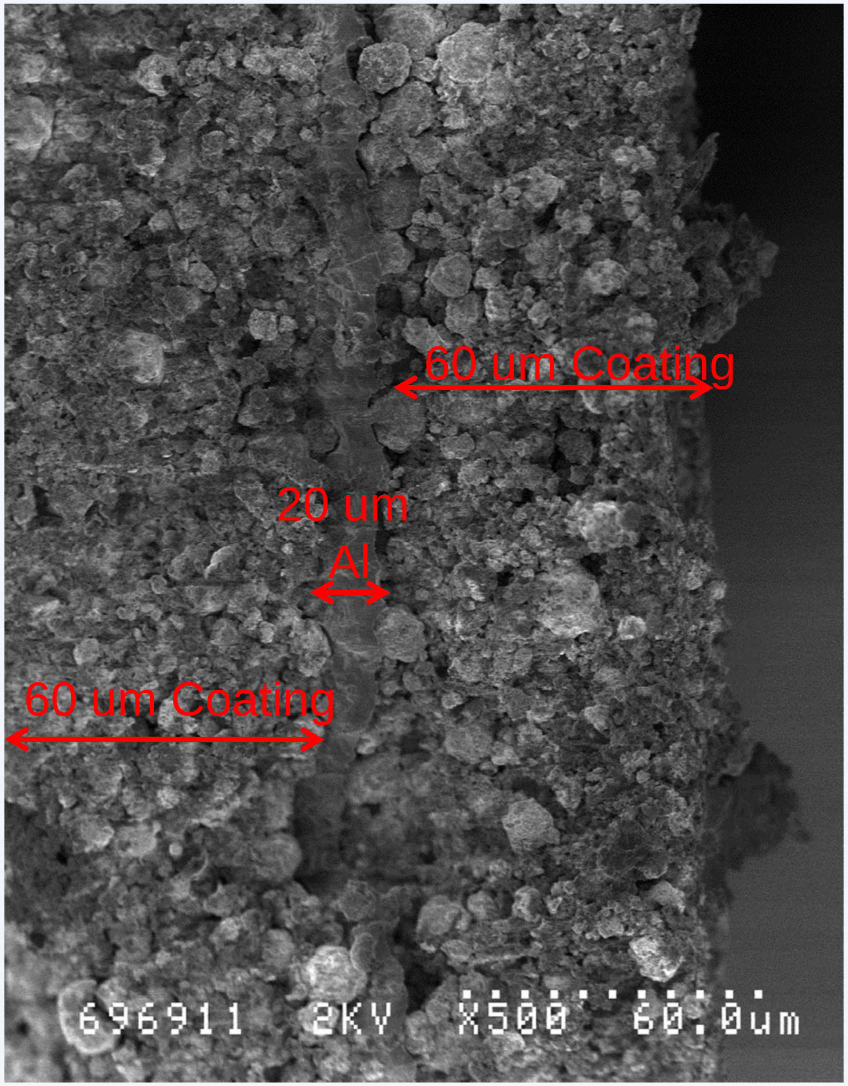
3×3 packs in various configurations

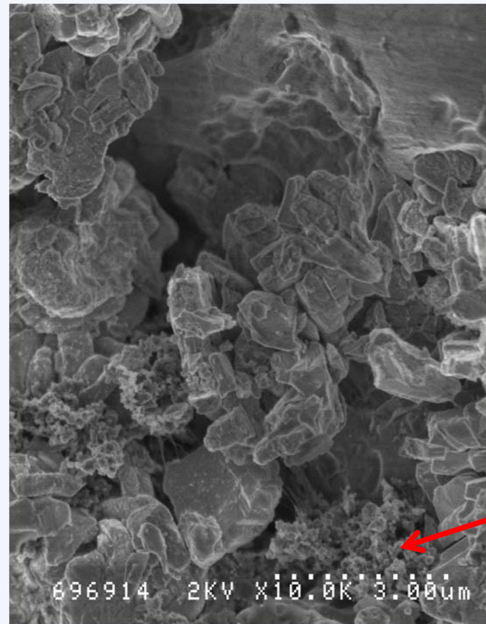
SEM, TGA, Surface area

Cell ID	Manufacturer	Model	Type	Chemistry	Weight [gr]	Tests	Failure mode
8	Proprietary	Proprietary	18650	Proprietary	44.259	{1, 2, 3, 1, 2, 3, 1, 2, 4, 1, 23}	Not failed yet

Test ID	Test Description	Reference document
1	Impedance spectroscopy at 100 % SOC	<links omitted>
2	Impedance spectroscopy at 0 % SOC	<links omitted>
3	20 cycles according to specification	<links omitted>
4	Cycling until cells reach 90 % of the specified capacity	

Cross-section of "new" cathode coating on each side of Al current collector





SEM of cathode particles

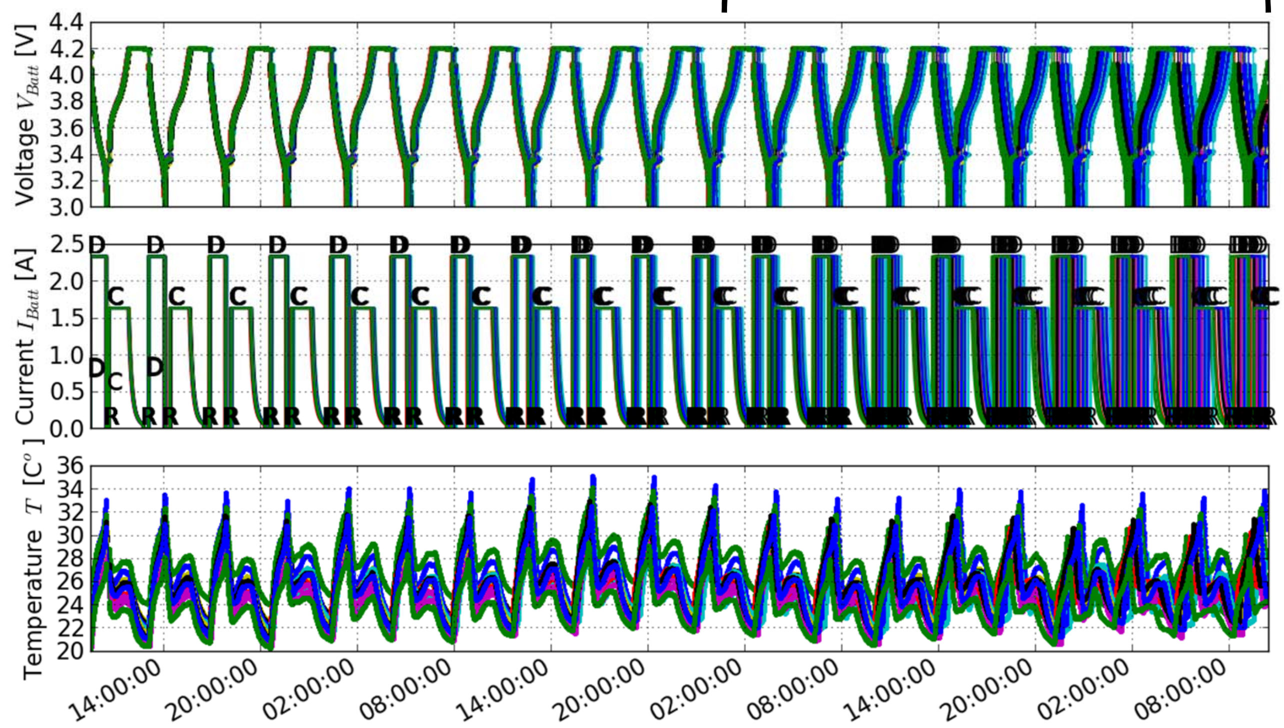
Conductive Carbon

SEM of Al – coating interface

20 um Thick Al

16 Cells Cycling on MACOR Test Stand

Cell performance diverges over time



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Summary and Next Steps

- Much work remains to be done to understand the issues of cell durability within a pack at both a material and system level.

- We will work closely with the NY-BEST testing group and others in the community to begin to formulate appropriate test and analysis protocols based on what is already in place and understood, as well as looking forward to developing deeper understandings that can be applied by the battery industry.

- Will continue to engage Industry partners, our Nano-Power Research Lab (NPRL), the Center for Sustainable Mobility (CSM), and our graduate students in the R&D work required.

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