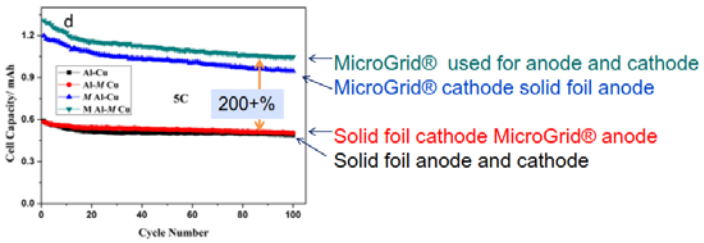
Disruptive Technology for Advanced Battery Development

Dexmet MicroGrid® expanded metal foils

Dexmet, is a name that has been associated with expanded metal products for primary and secondary batteries for the past forty years. To address the continued demand for thinner and lighter weight current conducting materials, Dexmet recently introduced MicroGrid® - a 25 micron thickness expanded copper and aluminum foil for lithium ion batteries.

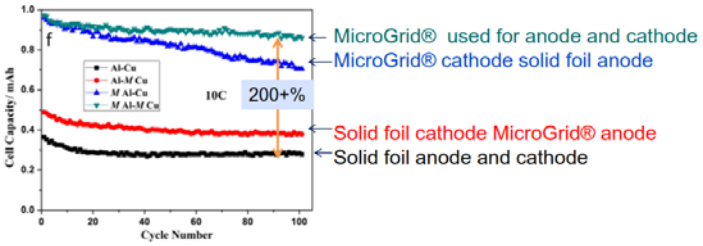
Since the introduction of MicroGrid®, Dexmet has provided free samples to any and all research groups and cell developers worldwide and the reported third-party testing has demonstrated a significant potential to enhance cell performance and cycle life. Comparative data was collected by maintaining consistency in all materials with the exception of exchanging the 10 micron solid foils for the 25 micron MicroGrid®. The 25 micron MicroGrid® can have an approximate open area ranging from 40% to 60%, giving it a mass equivalent consistent with 10 to 14 micron solid foils.

The following graphs demonstrate a 200% increase in available capacity, through 100 cycles, demonstrating a significant gain in performance.



5C Charging/Discharge Performance Results

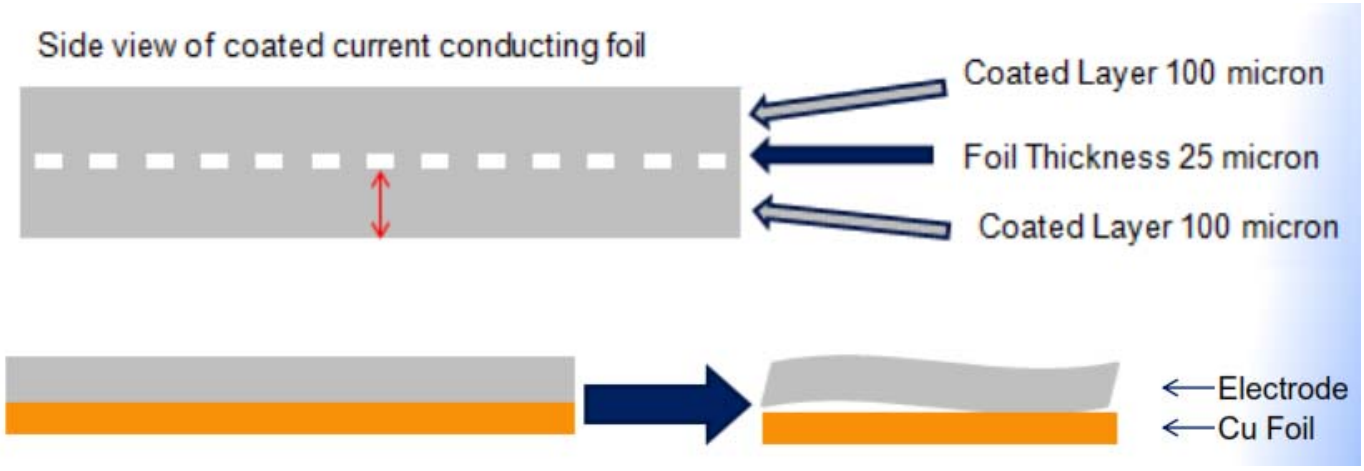
- Full Cells Produced with NMC and Graphite



10C Charging/Discharge Performance Results

- Full Cells Produced with NMC and Graphite

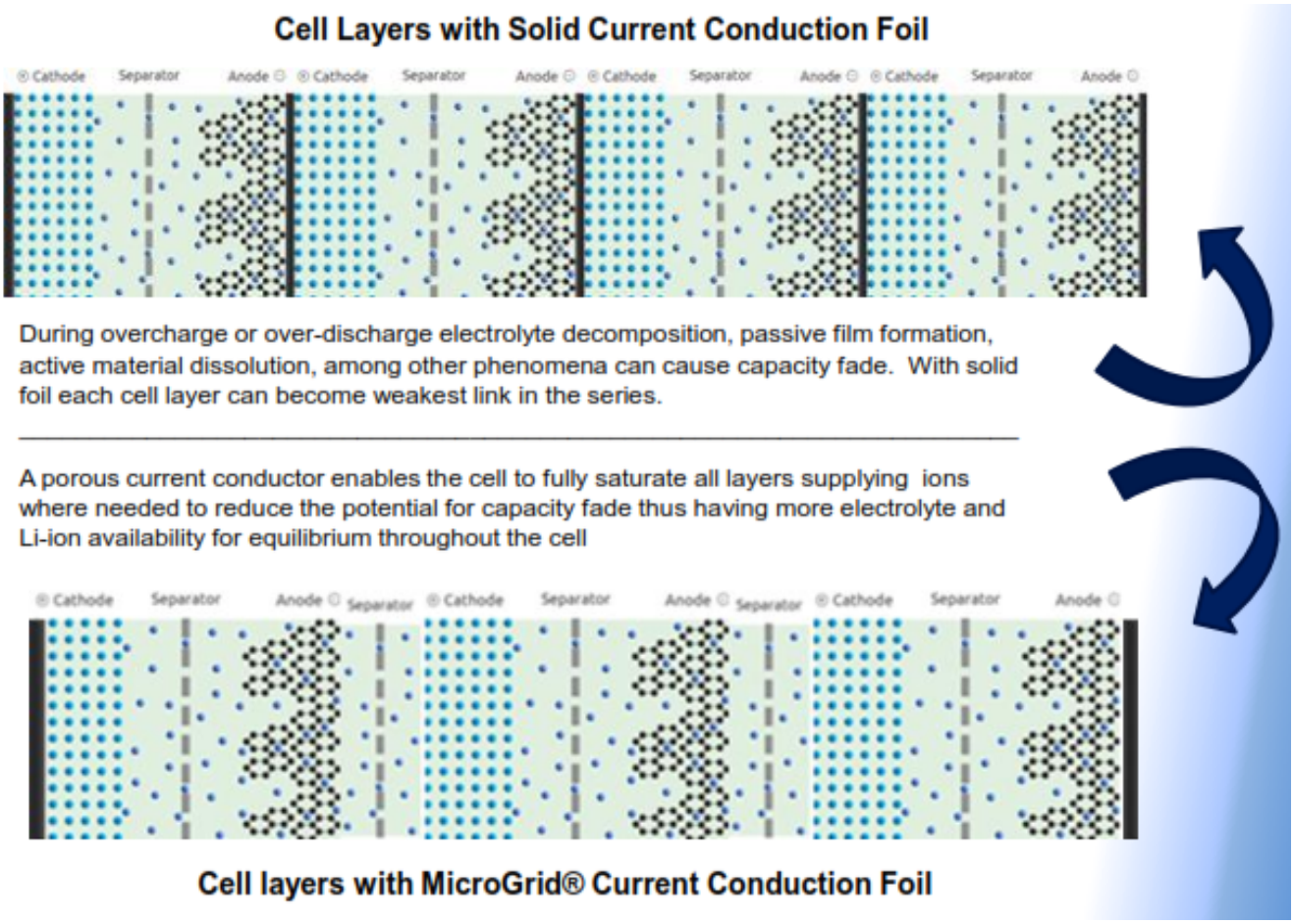
Although there has not been any research performed to provide a scientific explanation for the substantial improvement in performance, several hypotheses have been suggested. With approximately 50% open area, the mesh foil provides a granular bond across the open area which adds strength to the bond of electrode materials with foil surface. Delamination is one of the primary reasons for cell failure, thus with 50% of the surface bound across the foil, this additional strength can potentially offer extended cycle life.



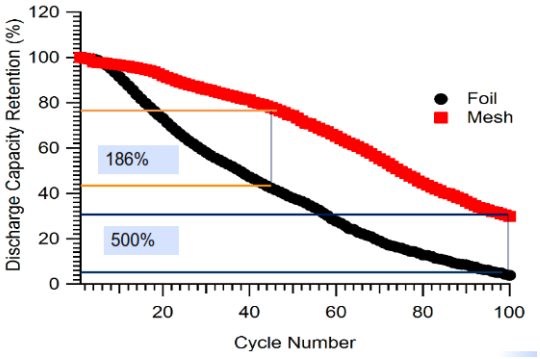
With added strength in the bonding across the foil, it is quite possible that the volume of binder dedicated to bonding to the foil surface can now be reduce allowing for a slight gain in capacity in the electrode. Dexmet is presently in discussions with a company that produces binders towards participation in a USABC program to determine if binder can be optimized to not only increase capacity but also reduce costs.

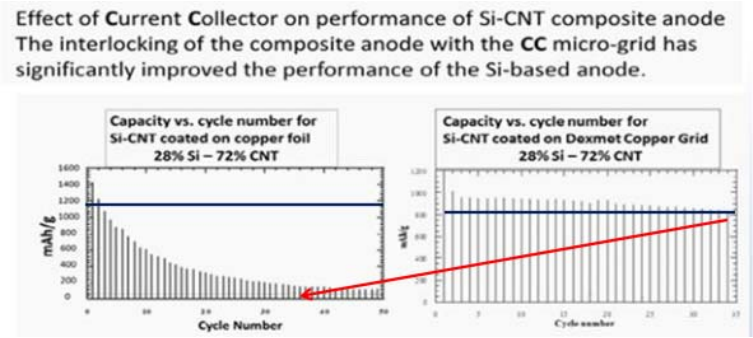
Capacity fade is another primary cause for reduced battery performance. In traditional cell design with solid foils, each layer functions somewhat independent of the other layers of the cell. Thus any cell degradation in a specific cell layer can draw down the capacity of the entire cell.

The porous nature of MicroGrid® allows the active ions and electrolyte materials to migrate throughout the entire cell to minimize the extent of degradation in the areas of the cell where decomposition is occurring.

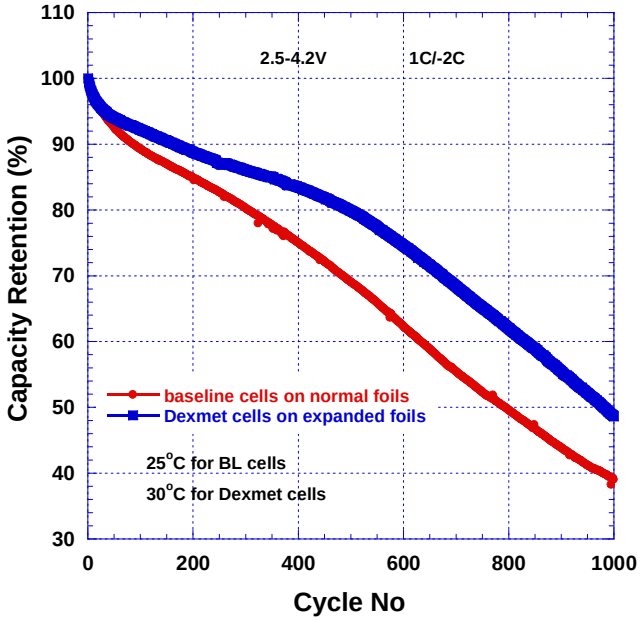


Reduced delamination and reduced capacity fade may help to explain to striking results observed in the following two charts where solid lithium and Silicon anodes were being evaluated. Further studies will have to be performed to measure and quantify capacity fade to determine if porosity is influential in its reduction.





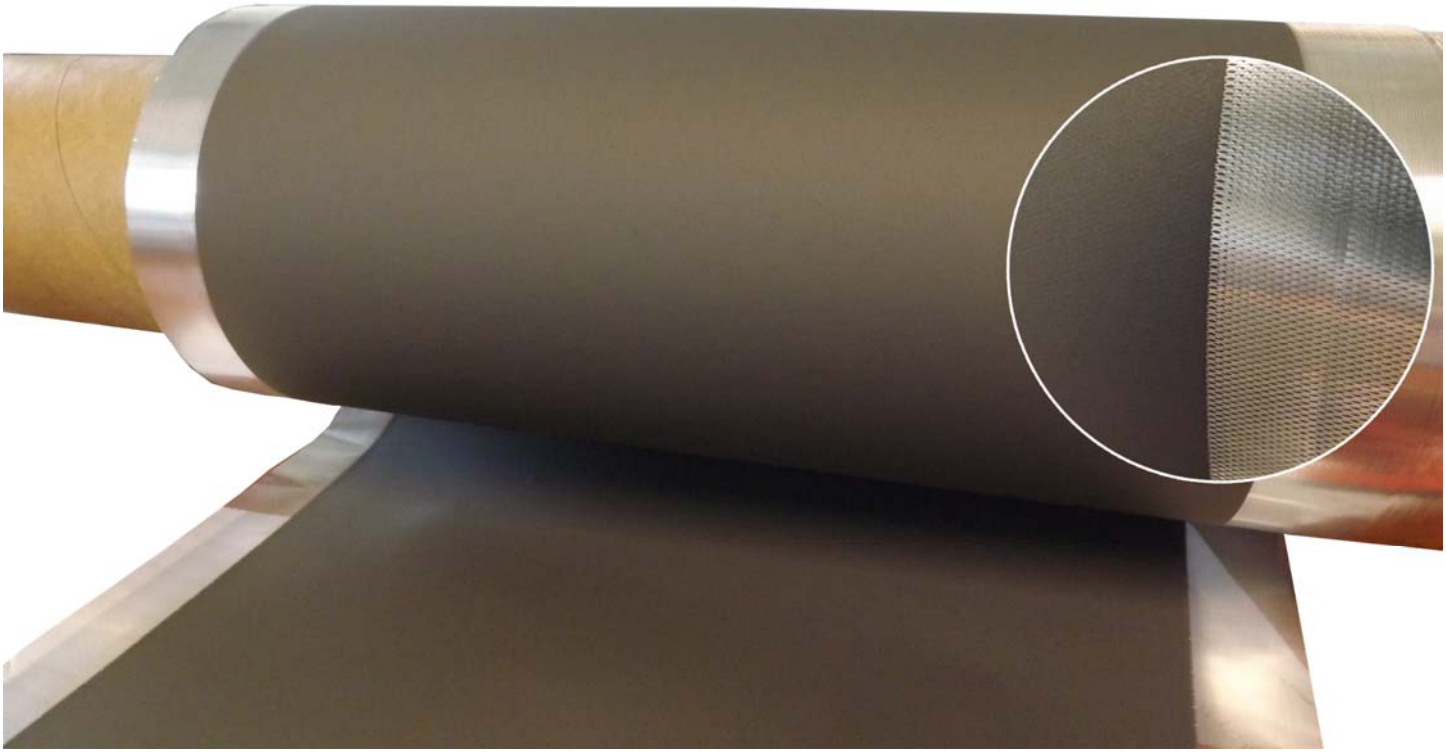
As the data presented in this report is primarily from coin cells, the next step was to verify that this same level of performance would carry over into full multi-layer cells. A comparative study was thereby performed with Oak Ridge National Laboratory to prepare 1.5 Ah pouch cells where all materials were consistent with the baseline graphite/NMC data from the ORNL library. Although a limited number of cells were produced, the comparison indicated as much as a 20% increase in capacity and capacity retention after 1000 cycles.



MicroGrid® foil is a disruptive technology with the potential to dramatically impact the performance and cycle life of lithium ion batteries, as well as other secondary battery chemistries. However, coating machines have traditionally been designed to accommodate solid foil as a current conducting substrate. As cell developers and battery companies begin to design production lines utilizing MicroGrid® foils, the porous nature will have to be taken into consideration. Dexmet is now engaging with many of the most recognizable names in the battery industry to adapt their coating systems to accommodate MicroGrid® foils, and are also working with coating machine suppliers in Asia, the US and Europe to develop the techniques and machine designs for optimal coating.

Coating foil on one side in a traditional coating setup will cause the electrode slurry to penetrate through the foil and onto the lower surface. To address this in prototype systems, Dexmet offers foils with an interleaf solid foil to capture seepage and avoid contamination of the machine parts.

In some machines, such as Frontier slot coating systems, a sacrificial backing can be incorporated into the system during coating and then is removed prior to the coating foil entering the drying oven. Optimally, a pre-drying source can be integrated to partially dry to coating foil immediately after coating. For other coating systems, an interleaf incorporated into the roll of foil can be carried through the drying process and removed during final collecting stage by inserting a second roller head.



Double Sided Single Pass Coating using MEGTEC Coater with Vertical Injection

For full rate production Dexmet is working with coating machine suppliers to utilize either a vertical inject head or systems with two opposing injection heads to coat both sides simultaneously. Due to the porosity, a vertical inject head will push the electrode slurry through the foil and coat the top side of the foil as well as the bottom. A proof of concept coating run was successfully performed at Megtec in Green Bay WI, demonstrating that a highly consistently coated surface can be achieved. Dexmet is working with several coating companies to develop techniques to optimize these processes.

As battery companies are now initiating the production of multi-layer pouch and 18650 cells for evaluation, Dexmet expects to have new performance data to report towards the end of 2016 and new cycle life data by Q2 2017.

For further information on Dexmet products, please contact John Hart at jhart@dexmet.com.

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