BRIGHTVOLT
SOLID-STATE POWER SOLUTIONS

BrightVolt Company Update

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About BrightVolt

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Company

- Formerly known as Solicore; re-branded in 2014.
  - Manufacturing history: sold over 15M primary Li-metal batteries.
  - Transition to rechargeable Lithium technology in 2018, and developing same for CE and e-mobility applications
- Backed by VCs and strategics including NSV and Caterpillar

NEW SCIENCE VENTURES

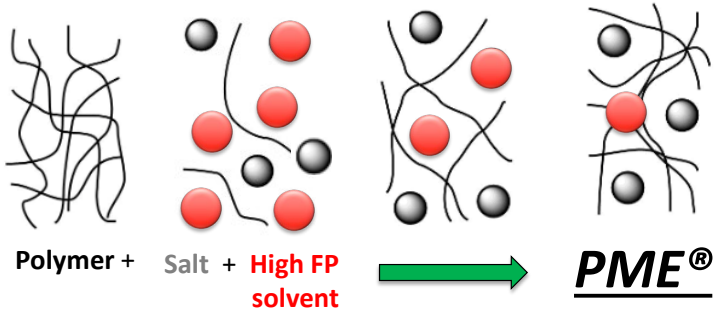
CATERPILLAR®

- Headquartered in Redmond, WA
- R&D based at The Battery Innovation Center in Newberry, IN.

Technology

Polymer Matrix Electrolyte (PME®)

- BrightVolt develops proprietary Polymer Matrix Electrolytes® for use in storage and conversion energy systems



End goal is to eliminate all free-flowing solvents

- Validate PME in 1Ah pouch cells

What PME Enables in Composite Electrodes Cell Manufacturing

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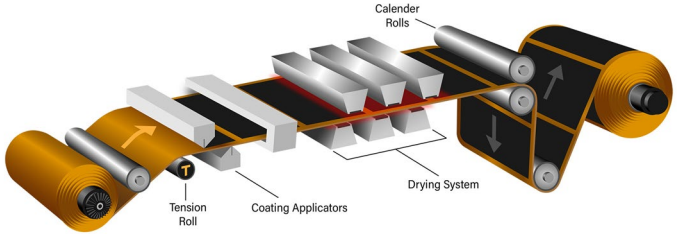
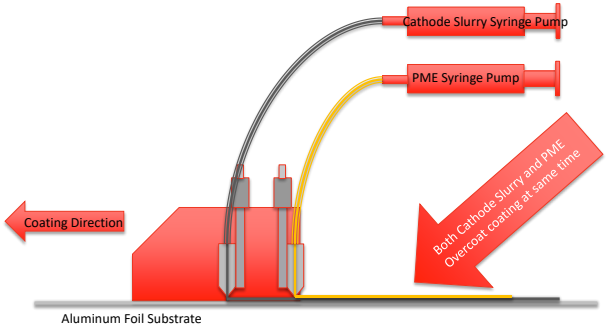
Front-End Electrodes Processing



Schematic: Double-sided Slot Die Coating



Schematic: Simultaneous multi-layer Slot Die Coating

Double-sided, simultaneous multilayers wet application with printing process advantages

- Increased throughput
- Reduced drying time and possibly eliminate calendering steps
  - Electrode processing cost reduction
- Simultaneous tri-layer of anode/PME/cathode also possible

What PME Enables in Composite Electrodes Cell Manufacturing

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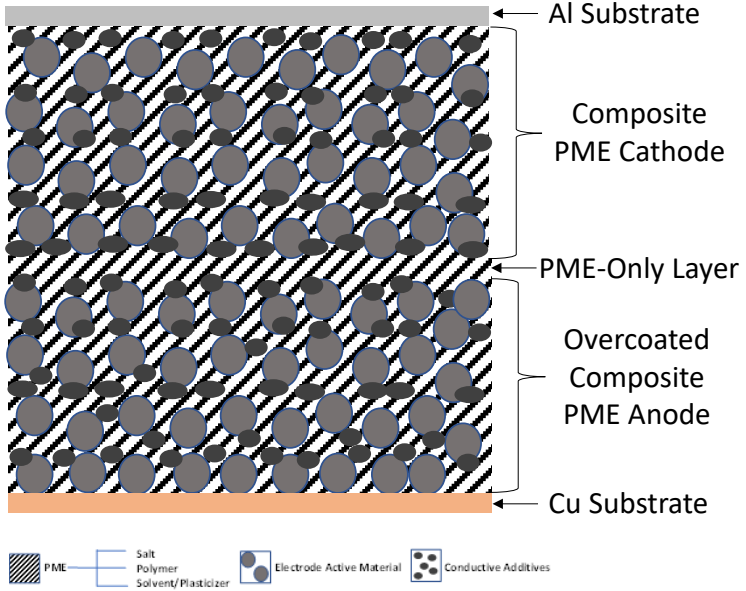
Back-End Cell Assembly



Multiple Advantages:

- No need for additional binder in the slurry - PME® already serves this function
- PME® acts as an adhesive glue between layers; **may not require external pressure** (none during 2Ah cells testing)
- Forms a continuous ensemble, **reducing interfacial resistances** and impedances critical for good rate/power performance
- PME polymeric property allows for high densification of electrodes, thereby **boosting energy density**

Where We Are: Gen1 PME Development & Validation

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Gen1 PME Activities

Development

- Reversible Voltage (0V - 4.2V vs Li/Li+)
- Conductivity (> 0.5 mS/cm)
- Mechanical Strength (> 0.5 GPa)
- Cyclability (> 500 cycles)

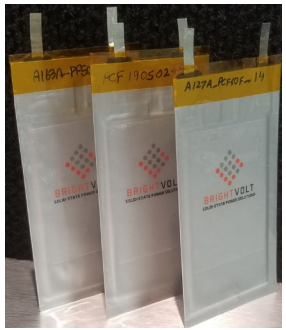
Development in Pouch Cells

- Characterize with well-established chemistries
- Demonstrate rechargeability
- Demonstrate scalability
  - 50mAh-to-2Ah cells
  - Small footprint (25cm^2)-to-large footprint (125cm^2) cells
  - Single layer, to multi-layer stacked, cells (12 layers)

Validation in 1Ah Pouch Cells

- Assembled 1Ah cells for performance and safety validation
  - BrightVolt internal qualification
  - 3rd Party external performance and safety validation

Scaling Up



50mAh - Double Layer

Anode (Double Sided with PME Coating)

125 mAh

Cathode (Single Sided with PME Coating)

Cathode (Double Sided with PME Coating)

Larger Footprint

Anode (Double Sided with PME Coating)

1.2Ah

Cathode (Double Sided with PME Coating)

Cathode (Single Sided with PME Coating)

Anode (Double Sided with PME Coating)

270 mAh

Cathode (Double Sided with PME Coating)

Cathode (Double Sided with PME Coating)

Increased Loadings

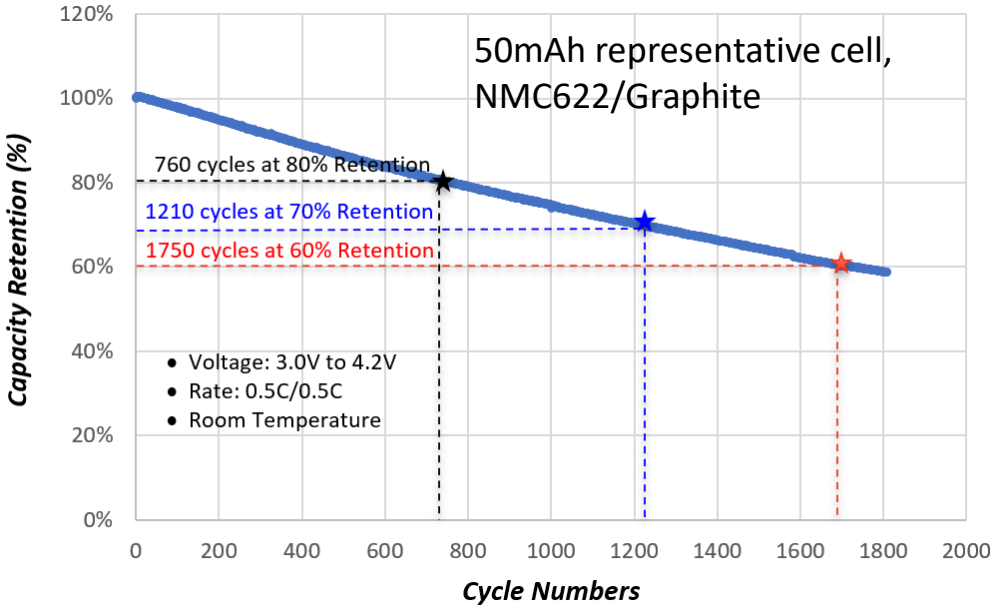
Anode (Double Sided with PME Coating)

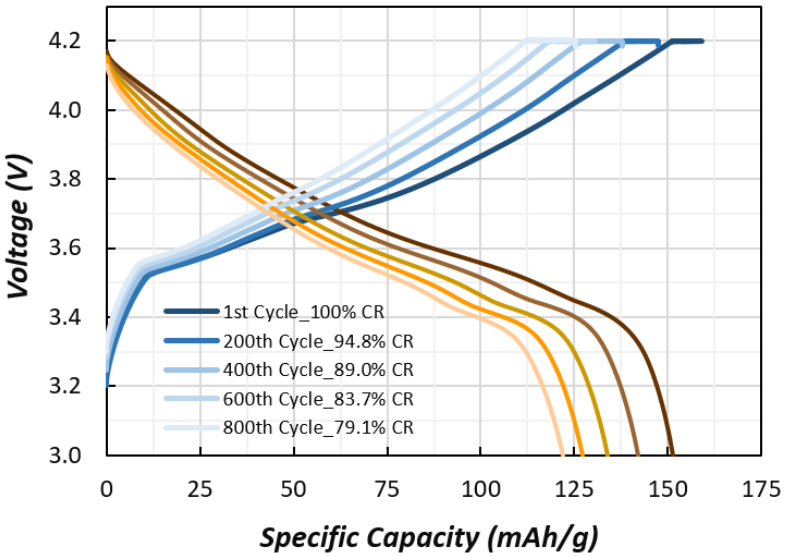
2.5Ah

Cathode (Double Sided with PME Coating)

Cathode (Single Sided with PME Coating)

Cycling Performance





Example Si-Gr Material Evaluation

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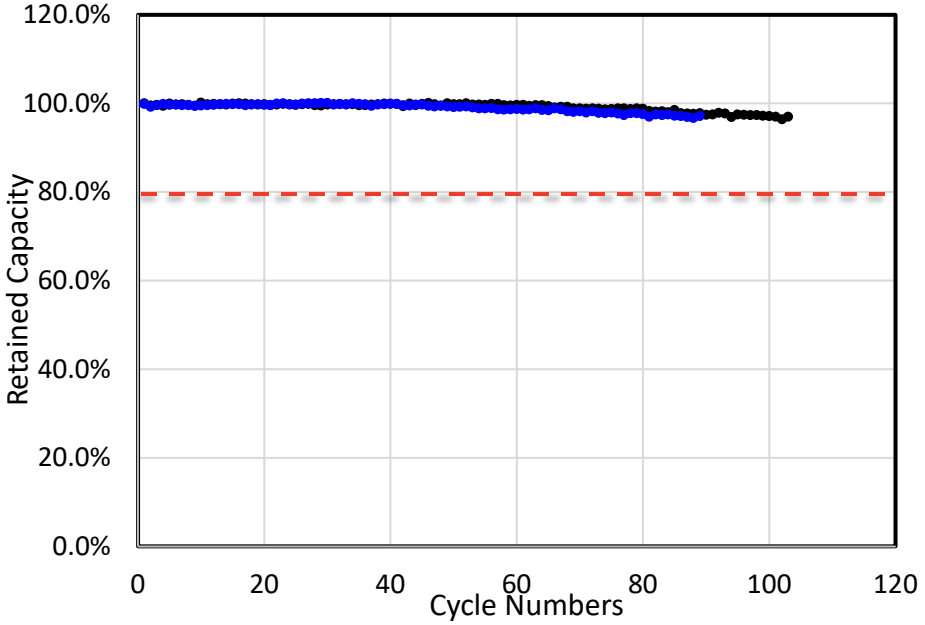
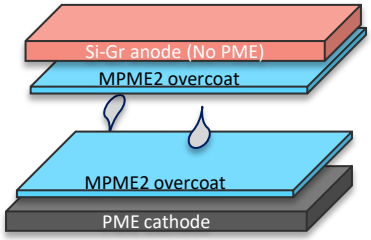
Electrodes with Example Si-Gr Material

Bare Si-Gr (%)	% Silicon	Specific Capacity (mAh/g)
20	~10	520
40	~20	806
80	~40	1033
100	~50	1400

- **Specific Capacities are based on PAA/CMC mixture**
- **Actual Si Content in Bare Material: 50%**

60mAh Cell: NMC811/Si-Gr (20% Si) Cycling Characteristics





Notes:

- No PME binder used in current Si-Gr anode formulation (liquid electrolyte only); however, cathode binder is PME
- Both anode and cathode are overcoated with PME for cell assembly

Final Comments

- At the early stages of developing PME® for Si/Si-Gr anodes.
- Exploring a collaborative Si/Si-Gr material provider partnership to develop electrodes and cells with PME to explore markets beyond liquid electrolytes via semi/solid-state cells.

Company Information

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Thank you!

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