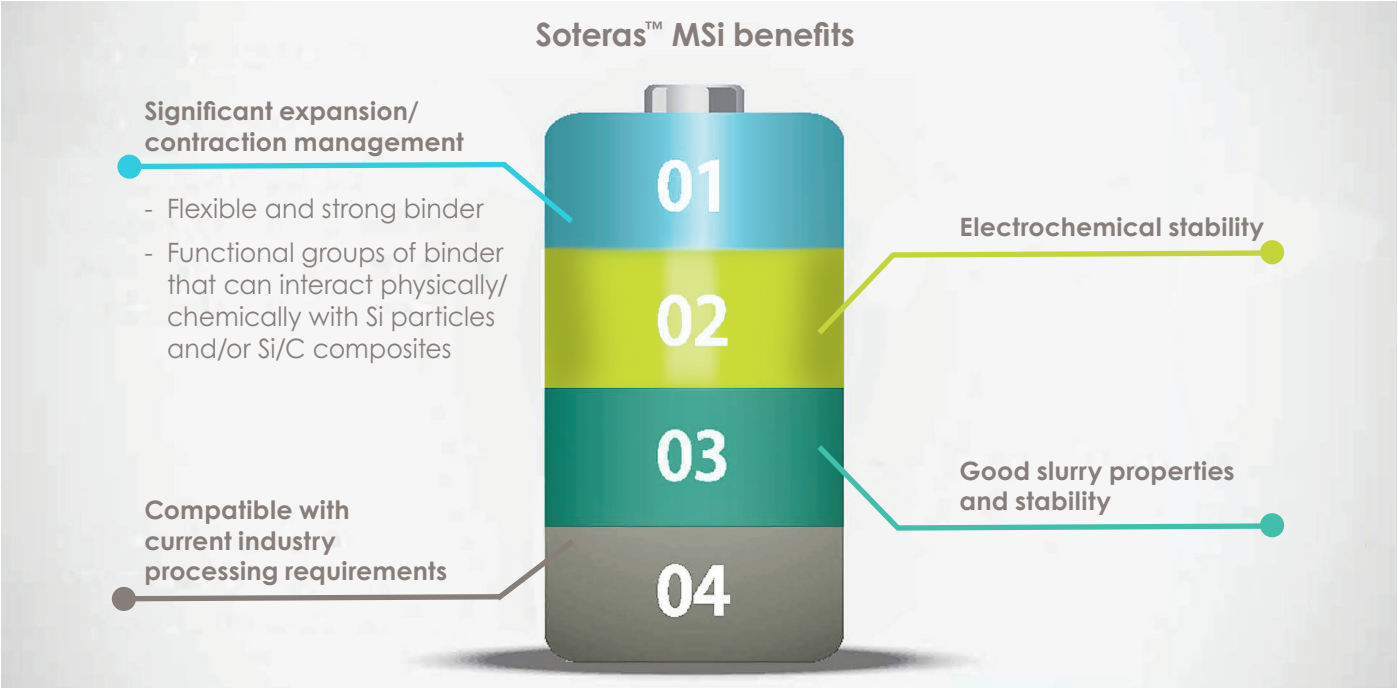
Soteras™ MSi Binder

innovative anode binder for higher-capacity lithium ion batteries

Soteras™ MSi is a unique binder for high-capacity silicon-based anodes in lithium ion batteries. It can easily be processed using standard industry practices. Soteras MSi binder's ability to control swelling results in superior cycle performance at capacities greater than 400 mAh/g when used with silicon oxide (SiOx), silicon composite (SiC), silicon oxide composite (SiOxC), or silicon graphene (Si-Gr) technologies.

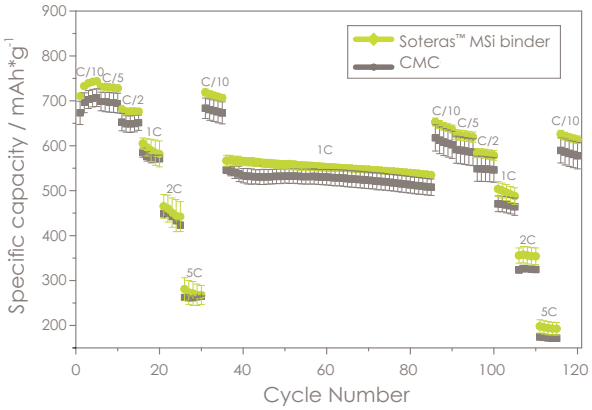


We at Ashland are **passionate, tenacious, solvers** who thrive on developing practical, innovative, and elegant solutions to complex problems in lithium ion battery manufacturing, always pushing the boundaries of what's possible, and advancing the competitiveness of our customers in the battery industry.

Our people bring exceptional product knowledge, technical support and industry insights to help our customers amplify the **efficacy**, refine the **usability**, add to the **allure**, ensure the **integrity**, and improve the **profitability** of their products and applications.

Improved performance at high C-rate

Independent data from Münster Electrochemical Energy Technology (MEET): SiC anode of 700mAh/g with FEC electrolyte additive



1M $LiPF_6$ EC:DMC 1:1 + 5% FEC electrolyte additive

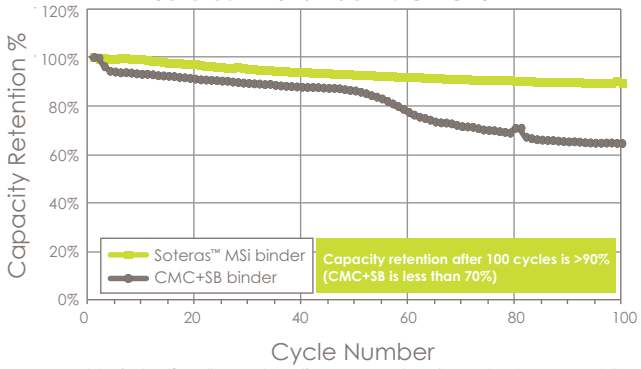
Ashland™
always solving

Why Soteras MSi is the binder of choice for silicon-containing anodes

Better capacity retention for multiple silicon types

Silicon oxide composite anode of 420 mAh/g

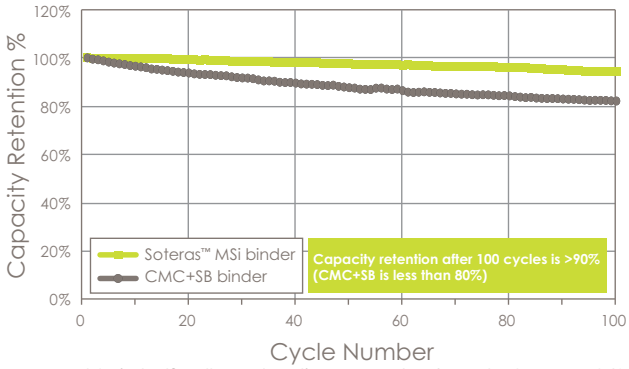
Cycle performance of SiOxC 420 mAh/g anode:
Soteras™ MSi binder vs CMC+SB



*Coin half cell test; loading = 5mg/cm²; cycle C-rate = C/3

Silicon composite (SiC) anode of 450 mAh/g

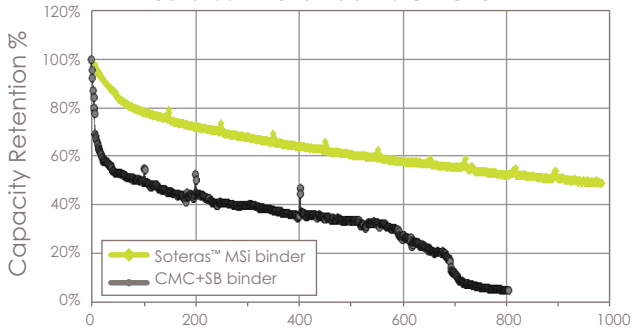
Cycle performance SiC 450 mAh/g anode:
Soteras™ MSi binder vs CMC+SB



*Coin half cell test; loading = 5mg/cm²; cycle C-rate = C/3

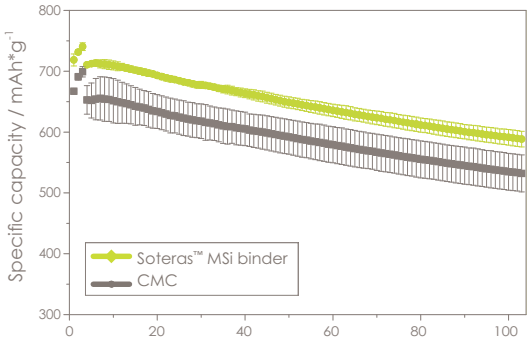
Silicon-Graphene (Si-Gr) anode of 600 mAh/g

Cycle performance of Si-Graphene 600 mAh/g anode:
Soteras™ MSi binder vs CMC+SB



*Coin half cell test; loading = 2 mg/cm²; cycle C-rate = C/3
Binder loading level 5.0% w/w based on active

Independent data from Münster Electrochemical Energy Technology (MEET): SiC anode of 700mAh/g with FEC electrolyte additive



1M $LiPF_6$ EC: DMC 1:1 + 5% FEC

Product Specifications

Commercially available Soteras™ MSi binder grades

Product Name	Component	Appearance	Viscosity (cPs)	pH	Moisture (%)
Soteras™ MSi Binder	MSi-A	White Powder	7,000-11,000[1] (2% solution)	6.5-8.5	0-10
	MSi-B	Clear Liquid	1,550-2,150[1] (100% solution)	N/A	N/A

[1] Brookfield, spindle #4 at 30 rpm

Ashland Soteras™ MSi binder is a 2-component system, which can be used to replace conventional CMC and SB binder systems.

- Suggested Dosage: 2.5-5wt% of anode active material, depending on target capacity
- Ratio: Soteras™ MSi-A (95%): Soteras™ MSi-B (5%)
- Soteras™ MSi-B is NOT a latex

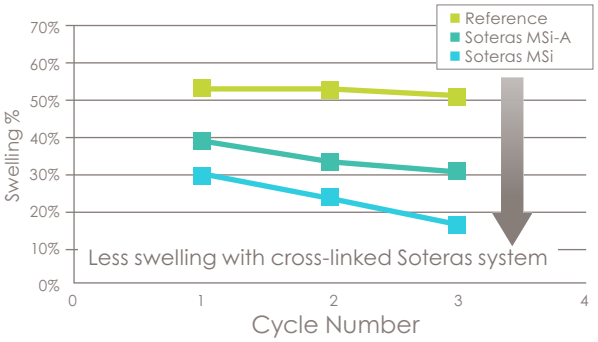
A detailed slurry preparation guide is available upon request.

Ensures less swelling

Soteras MSi binder controls swelling as determined by SEM after first full lithiation

The cells with Soteras MSi binder have less swelling, thus are able to handle the large volume change of Si-based anode during Li+ insertion.

Soteras MSi controls swelling compared to reference CMC+SB binder in a silicon oxide composite anode of 1500 mAh/g



Using a cell with a sensitive micrometer enables insight on cycling

Connected to a BTS channel to permit electrochemical and in-situ thickness information

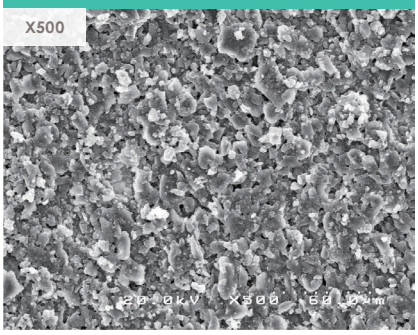
Control of cell expansion:

- minimizes degradative mechanisms
- minimizes new SEI formation for better cycle life

Better Adhesion Contributes to Longer Cycle Life

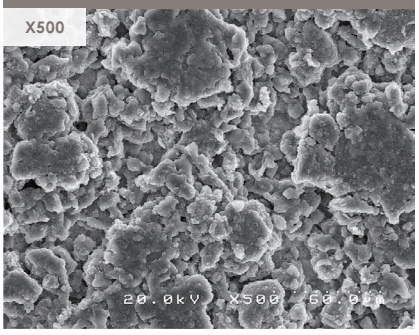
SEM image of Si-Gr anode after first lithiation

Soteras MSi



uniform, less expansion

CMC+SB



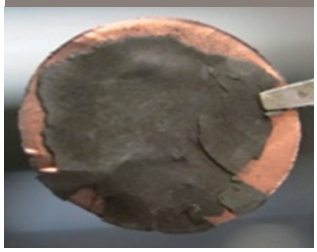
chunky, more expansion

LiB coin cell using Si composite

Soteras MSi

100 cycles smooth

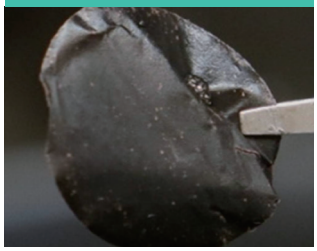
CMC+SB



100 cycles delaminated

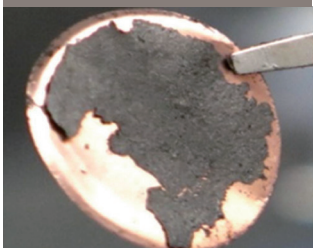
LiB coin cell using Si graphene

Soteras MSi



400 cycles smooth

CMC+SB



100 cycles delaminated

Ashland locations supporting the LiB industry

Electrode coating and coin cell testing lab

Initial efficiency(SEI formation)
Cycle life (Capacity retention)
C-rate dependence
AC impedance
Cyclic voltammetry

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