Soteras™ CCS Binder

for both PE & PP Ceramic-Coated Separators in Lithium Ion Batteries

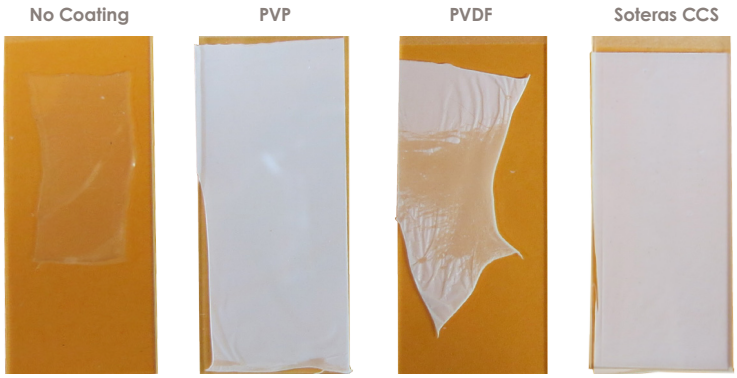
We are **passionate, tenacious, solvers** who thrive on developing practical, innovative, and elegant solutions to complex problems in lithium ion battery manufacturing, always pushing the boundaries of what's possible, and advancing the competitiveness of our customers in the battery industry.

To that end, Ashland has developed Soteras™ CCS, a unique binder for lithium ion batteries that allows effective ceramic coating on polyolefin separators to reduce film shrinkage during thermal stress. It is a two-component system compatible with typical coating processes. It delivers good lithium ion permeability and minimizes negative effects on cell electrochemistry (cycling or rate study).

Soteras CCS binder advantages:

- Novel cross-linking system that enables ceramic-coated separators to meet industry heat shrinkage standards
- Provides improved mechanical and thermal stability
- Works with both polyethylene (PE) and polypropylene (PP) separators in both single- and multi-layer structures
- Compatible with current battery industry standard aqueous coating process techniques
- High slurry stability
- No solubility in electrolyte

Soteras CCS binder
provides excellent heat resistivity
(shrinkage temperature >140°C)



Laboratory Trial Conditions:

Ceramic powder added to binder solution to make slurry

Use of 7% w/w binder vs ceramic at 25% solids

Ceramic slurry coated on 14µ PE separator to produce coating of 2-4 microns after drying (aqueous 30 min. at 100°C)

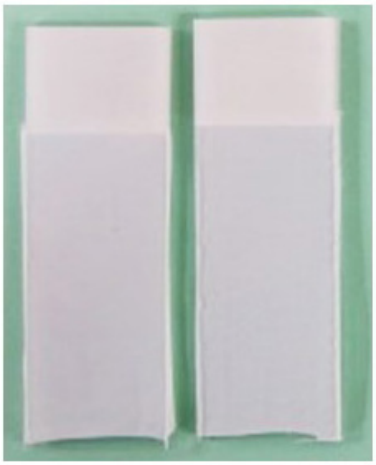
Shrinkage test by heating between glass slides at 140°C or heating single sheet in folder

A primary purpose of the ceramic-coated separator in lithium ion batteries is to increase temperature tolerance and to provide mechanical stability. Heat shrinkage of the separator film can profoundly affect the lifespan and safety of lithium ion batteries. The coating on the separator provides a safety benefit to the cell by providing a heat-resistant layer.

Soteras™ CCS binder has been formulated to work equally effectively on both polyethylene (PP) and polypropylene (PP) separator substrates.

PE Separator

PP Separator



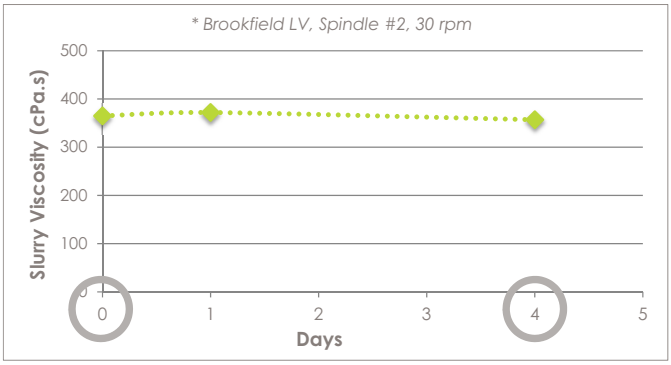
The unique, two-component Soteras CCS binder system, based on Ashland's core cellulosic chemistry, employs cross-linking to enable the ceramic-coated separator to meet industry heat shrinkage standards. Polyolefin separators produced with Soteras CCS binder show virtually no shrinkage after exposure to 140°C for 60 minutes. The binder can be applied to one or both sides of the separator film, depending on economics and desired performance. Further, testing has shown Soteras CCS binder to be electrolyte insoluble, to ensure stable performance over a longer period compared to other binder materials.

Additionally, Soteras CCS binder is compatible with standard industry coating techniques so it is easy to incorporate without significant downtime or costly capital investments. Soteras CCS binder-based ceramic formulations provide good wettability and uniform coating via machine-applied micro-gravure process.

Soteras CCS binder-based ceramic formulations are stable and compatible with standard aqueous coating processes.

Room Temperature

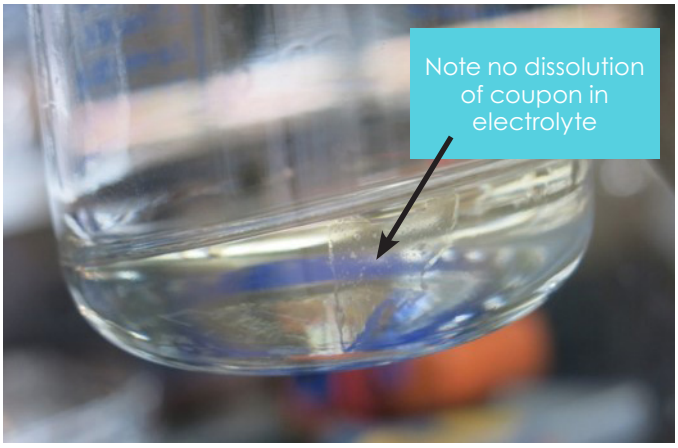
Dispersing & Slurry Stability



Soteras CCS binder for high-quality separator coatings

Outstanding Film Application

Soteras CCS insolubility in electrolyte ensures long-term stability



Soteras CCS binder has stability in 1 M LiPF6 in EC/PC (1:1 Vol%) heated to 135°C for 30 min

Optimum drying is achieved at 80°C for 180 seconds, which produces a fast-forming, non-tacky finish that can be rolled immediately and heated further for complete curing.

Product specifications

Product Name	Component	Appearance	Viscosity (cPs)	pH	Solids Content % w/w
Soteras CCS Binder	CCS-A	Hazy solution	20,000-50,000 (25°C #4/30 rpm)	6-8	19-21 (aqueous solution)
	CCS-B	Clear liquid	1500-3000 (25°C #4/30 rpm)	NA	100

Soteras CCS binder is a two-component system. Cross-linking is completed during drying process.

Suggested binder dosage: 4.5-7.5wt% of ceramic powder (recommend use Boehmite)

Preferred ratio: Soteras CCS-A (90%): Soteras CCS-B (10%)

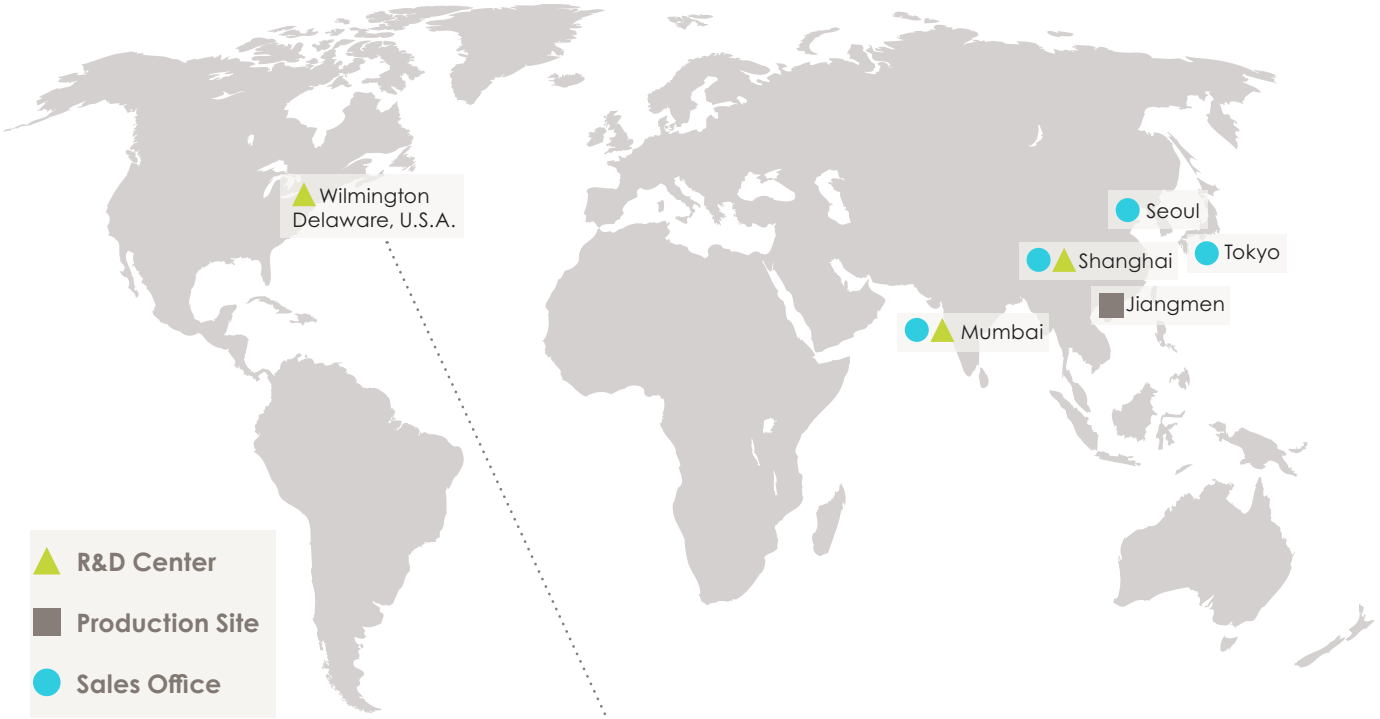
A detailed slurry preparation guide is available upon request.

Ashland's Industrial Specialties business includes five market-focused units: Paints and Coatings, Adhesives, Construction, Energy and Performance Specialties. The products they make are used in a diverse cross-section of markets, including building materials, packaging, tapes, labels, engineered wood products, structural assembly, oil and gas production, printing, textiles, metal working, batteries, electronics and others.

Our products are used across these markets in upstream manufacturing and processing. They are also used in product formulations to enhance the usability or efficacy of the end product to benefit consumers.

Our customers enjoy better product integrity from ingredients that are of consistent quality, naturally derived, or have less environmental impact than competitive ingredients. Often, our team of solvers are also able to help our customers manufacture their products more profitably. Ultimately, downstream users – be they processors or end consumers – benefit from goods that are more effective, more easily used, more environmentally compatible, or more appealing.

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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