

FyreWrap® LiB Performance Materials

Introduction

Unifrax's FyreWrap LiB (Lithium-ion Battery) Performance Products are a family of high-temperature, lightweight insulating materials that are designed to prevent thermal runaway in lithium-ion battery applications. Unifrax combines material science with industry knowledge to tackle one of the most important safety issues in today's large format lithium-ion battery applications. From cell-to-cell isolating thermal barriers, to whole pack solutions, Unifrax delivers an engineered platform with unparalleled designs to offer the ultimate fire protection in lithium-ion battery containment.

Building on our thermal management expertise and manufacturing excellence, combined with our extensive experience in aerospace, automotive and fire protection applications – Unifrax offers a customized solution for any lithium-ion thermal runaway prevention. The base of our technology starts with our fiber manufacturing techniques. Unifrax produces multiple fiber chemistries such as alkaline earth silicate fibers, refractory ceramic fibers, micro-fine glass fibers and polycrystalline fibers. Dependent upon the desired characteristics of the finished product, we convert these fibers into many different forms with varying options for additional enhancements.

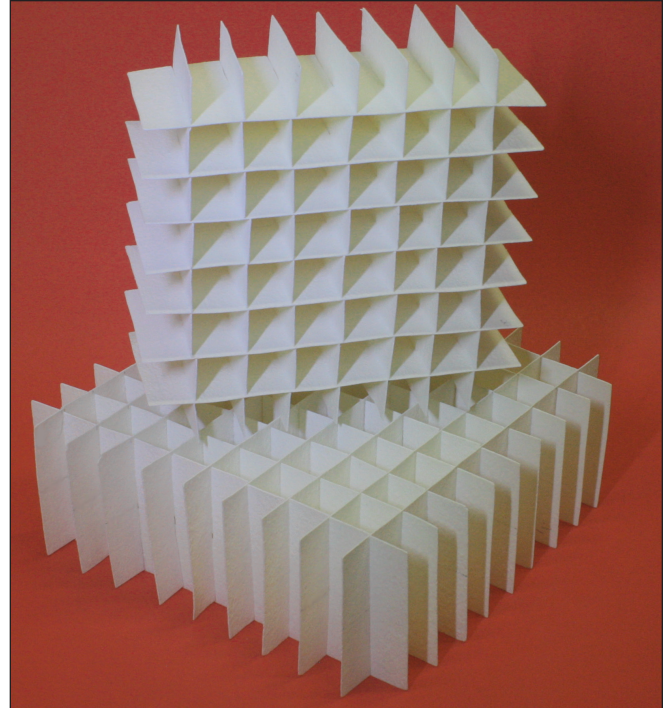
FyreWrap LiB Performance Products

Unifrax's FyreWrap LiB Performance Materials are available in the following forms all of which serve as heat shields, thermal barriers, and thermally isolating solutions designed to stop thermal runaway and to prevent cascading battery fires:

- FyreWrap LiB Papers
- FyreWrap LiB Felts
- FyreWrap LiB Shapes
- FyreWrap LiB Coatings and Films

Applications

- Electric Vehicles
- Mass Transit Systems
- Air Transportation Packaging
- Electric and Hybrid Marine
- Energy Storage Systems (ESS)
- Battery Cell, Module and Pack Thermal Barriers



Capabilities and Characteristics

- Containing thermal runaway events
- Providing radiant barriers between cells
- Preventing cascading fires
- Preventing transfer of internal heat to external combustibles

Ultimate Protection with FyreWrap LiB Performance Materials

Our purpose is based on our commitment to produce high-quality specialty products that help our customers save energy, reduce pollution and improve fire safety. Supporting and exemplifying our purpose statement, Unifrax is developing new fire-resistant materials for lithium-ion battery fire protection. At the forefront of this technology is our team of engineers and scientists. We invite open collaboration with our team, as this is a global issue and want to bring together minds and companies with mutual intentions – to tackle the safety issues that surround the current and next generation energy storage technologies.

We believe that each customer is unique and want to offer solutions that cater to each application's performance criteria, cost structure, and product handling needs. We value joint development and collaboration to help our customers reach an optimal solution. Contact us for additional information about our FyreWrap LiB Performance Hybrids.

Ask us about the following technologies and enhancements:

- Resin moldable felts and papers
- Adhesive and foil backings
- Hybrid fiber systems
- Encapsulation and lamination
- Rigidization of components
- Phase change and endothermic impregnation
- Fire retardant additions
- Pre-formed shapes capabilities

Typical Product Properties

	Product	Thickness	Density	Temperature Grade
Grade	Form	(mm)	(kgs/m ³)	(°C)
LiB	Paper	0.7-12	144-192	≤1430
LiB	Felt	6-25	64-152	≤1600
LiB	Shapes	6-76	208-512	≤1600
LiB	Coatings and Films	<2	----	≤1100

FyreWrap LiB Papers

- Non-woven fiber matrix
- Uniform lightweight flexible sheets
- Easy to wrap, shape or cut
- Excellent chemical stability
- Suitable for temperatures up to 1430°C
- Exceptionally resistant to thermal shock
- Durable and provides sound absorption
- Low thermal conductivity

FyreWrap LiB Felts

- Non-woven fiber matrix; expands on papers by increasing thickness and lowering density
- Compressible but resilient
- Conform to irregular surfaces while still maintaining shape
- Impregnated with thermosetting resins

- Easy to wrap, shape or cut
- Suitable for temperatures up to 1600°C
- Exceptionally resistant to thermal shock
- Durable and provides sound absorption
- Low thermal conductivity

FyreWrap LiB Shapes

- Pre-formed components designed to meet specific application requirements
- Complex shape capabilities
- Suitable for temperatures up to 1600°C
- Exceptionally resistant to thermal shock
- Durable and provides sound absorption
- Low thermal conductivity
- Lightweight and energy efficient
- Resistant to corrosion, water and oil damage
- Reaches steady state quickly
- Directs and contains heat

FyreWrap LiB Coatings and Films

- Ultra-lightweight and energy efficient
- Electrically non-conductive
- Proprietary fire blocking technology-protect structures and substrates
- Specifically designed for applications demanding extremely lightweight materials
- Add as an enhancement to any thermally isolating materials



FyreWrap

Form C-1548
Effective 3/17
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The test data shown are average results of tests conducted under standard procedures and are subject to variation. Results should not be used for specification purposes.

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Unifrax I LLC
Corporate Headquarters
600 Riverwalk Parkway
Suite 120
Tonawanda, New York 14150
Telephone: 716-768-6500
Internet: www.unifrax.com
Email: info@unifrax.com