

## FyreWrap® LiB Papers

### Introduction

FyreWrap® LiB (Lithium-ion Battery) Papers from Unifrax are a family of high-temperature, lightweight insulating materials designed to prevent thermal runaway propagation in lithium-ion battery applications.

Building on our thermal management expertise and manufacturing excellence, combined with extensive experience in aerospace, automotive and fire protection application, Unifrax offers customized solutions for lithium-ion thermal runaway propagation prevention.

The base of our technology starts with our fiber manufacturing techniques. Unifrax offers a variety of fiber types such as low bio-persistence fibers, refractory ceramic fibers, micro-fine glass fibers and polycrystalline fibers. Dependent upon the finished product's desired characteristics, these fibers are converted into different forms with varying options for additional enhancements.

### Properties

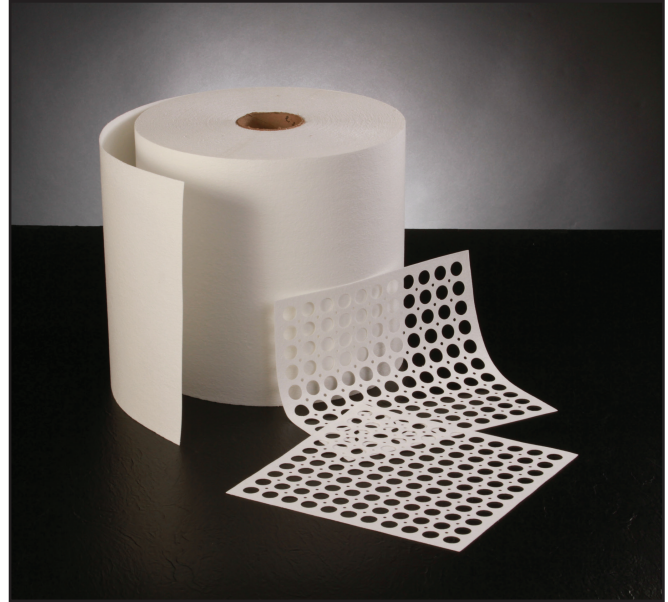
- Fire resistant, flame barrier
- Electrically insulating
- Low thermal conductivity / thermal insulating
- Suitable for temperatures up to 1430°C
- Uniform lightweight flexible sheets
- Easy to wrap, shape or cut
- Excellent chemical stability
- Exceptionally resistant to thermal shock
- Non-woven compressible fiber matrix

### Capabilities

- Thermal runaway propagation prevention
- Short circuit prevention and electrical protection
- Cascading fire prevention
- Thermal isolation and containment

### Applications

- Cells (external to cell)
- Battery modules
- Battery packs
- Packaging for transportation



### Markets

- E-Mobility
- Grid Storage
- Energy Storage Systems (ESS)
- Military
- Aerospace
- Consumer Electronics
- Medical
- Transportation packaging

Customer requirements are unique and Unifrax offers solutions that cater to each application's performance criteria, cost structure, and product handling needs. The information presented refers to our core products and their typical characteristics. Unifrax offers application support for many specifications and/or enhancements, such as:

- Adhesive and foil backings
- Encapsulation and lamination
- Fire retardant additions
- Hybrid fiber systems
- Rigidization of components
- Resin moldable additives

Please contact us to discuss additional enhancement requirements.

## FyreWrap LiB Papers Typical Product Properties

Paper Grade		FX40	FX50	FX70	FX45	IN50	IN70
<b>Physical Properties</b>							
Color		Off-White	White	White	White	White	White
Temperature Grade	°F	1600	2300	2300	2600	2300	2300
	°C	870	1260	1260	1427	1260	1260
Melting point	°F	1800	3260	3260	3500	2390	2390
	°C	982	1793	1793	1927	1310	1310
Density (kgs/m <sup>3</sup> )		208	192	160	288	152	160
Fiber Index <sup>(1)</sup> (% wt)		40	50	70	45	>50	>70
LOI <sup>(2)</sup> (incl. binder, % wt)		9.5	6.5	7.0	8.0	<12%	<12%
Dielectric strength (V/mil, ASTM D149)			60-100	70-140			50-90
<b>Strength</b>							
Tensile (PSI)		86	102	94	136	36	51
<b>Compression (PSI % Deformation)</b>							
10%		.6	1	1.3	3	—	—
25%		3	6	5.8	16	—	—
50%		27	35	22	44	—	—
<b>Chemistry (% Wt)</b>							
Al <sub>2</sub> O <sub>3</sub>		32-35	47-52	47-52	58-60	—	—
SiO <sub>2</sub>		42-46	48-53	48-53	40-42	62-67	62-67
Na <sub>2</sub> O		<2	<0.5	<0.5	<0.3	—	—
Fe <sub>2</sub> O <sub>3</sub>		<2	<0.5	<0.5	<0.1	—	—
CaO		—	—	—	—	28-33	28-33
MgO		—	—	—	—	1-6	1-6
Trace Elements		—	—	—	—	<1	<1
<b>Nominal Thickness (mm)</b>							
0.8				X			
1				X		X	X
2			X	X	X	X	X
3		X		X	X	X	X
6			X			X	X
Other thicknesses / sizes may be available on request							

**Notes:**

(1) Represents the percent by weight of fiber in the material.

(2) Represents loss in mass at 1000°C.

Unifrax offers many UL listed FyreWrap® product forms and FyreWrap fire protection materials for passive fire protection applications. Unifrax has received the following UL certifications and/or met the following standards listed pertaining to classes of products most similar to those listed above: UL 94, UL 723, ASTM E84, ASTM E136, ASTM E1529 (UL 1709).



Please contact Unifrax for your specific design requirements.



The following is a registered trademark of Unifrax: FyreWrap.

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.

Product Information Sheets are periodically updated by Unifrax. Before relying on any data or other information in this Product Information Sheet, you should confirm that it is still current and has not been superseded. A Product Information Sheet that has been superseded may contain incorrect, obsolete and/or irrelevant data and other information.