

## Fiberfrax® Ceramic Fiber

### Introduction

Fiberfrax® ceramic fibers are a family of high-temperature fibers designed to be used in a variety of industrial and commercial applications. Manufactured from alumina-silica materials, Fiberfrax fibers are chemically inert. Some of the unique properties these fibers offer are:

- High-temperature stability
- Low thermal conductivity
- Low heat storage
- Excellent thermal shock resistance
- Lightweight

Fiberfrax fibers are available in a variety of chemistries and diameters which can service a wide variety of applications. In addition, these fibers can be further modified by chopping or by removal of the unfiberized particles (called shot). Lubricants can also be added to the fiber to enhance fiber properties.

Fiberfrax fibers exhibit excellent chemical stability and resistance to attack from most corrosive agents. Exceptions include hydrofluoric acid, phosphoric acid and strong alkalis. Fiberfrax fibers also effectively resist oxidation and reduction. If wet by water or steam, thermal and physical properties are restored upon drying. Fiberfrax fibers contain no water of hydration.

### Fiberfrax Bulk Fibers

Fiberfrax Bulk Fibers are manufactured to be used as feedstock in manufacturing processes or other applications where product consistency is critical. Manufactured on large, computer-controlled furnaces, these products provide customers with consistent material properties. Fiberfrax Bulk Fibers are typically used in the manufacture of other ceramic fiber based product forms such as:

- High-temperature boards, felts, and papers
- Combustion chambers for commercial and residential boilers
- Riser sleeves for molten metal casting
- Fireplace logs and panels for gas fireplaces
- Tap out cones for molten metal applications
- Specialized vacuum-formed shapes

These bulk fibers can also be directly used as high-temperature fill and packing material in a variety of high-temperature applications, such as:

- Expansion joints
- Furnace base seals
- Tube seals
- Burner tile packing
- Chimney insulation



### Fiberfrax 7000 Series Fiber

Fiberfrax 7000 Series fibers are manufactured from high-purity alumina-silica materials for use in applications up to 2300°F (1260°C). These products are manufactured on computer-controlled, state-of-the-art furnaces to provide customers with consistent fiber properties. Fiberfrax 7000 Series fibers can also be chopped into several grades (coarse, medium, and fine) to provide customers with a fiber ideally suited for their application. Benefits of Fiberfrax 7000 Series fibers include:

- Low thermal shrinkage at high temperatures
- Consistent fiber properties
- Several chopped grades

### Fiberfrax 6000 Series

Fiberfrax 6000 Series fibers have many of the same properties as the 7000 Series fibers. The main difference is that 6000 Series fibers are manufactured from kaolin clay rather than high-purity alumina-silica raw materials. Since kaolin is a mined material, it may contain impurities such as  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$ , and  $\text{Na}_2\text{O}$  as listed in the chemical composition chart on page 2. Even with these impurities, Fiberfrax 6000 Series fibers can provide an effective solution in many vacuum-forming and related applications.

Refer to the product Material Safety Data Sheet (MSDS) for recommended work practices and other product safety information.

## Typical Product Properties

Product Chemistry	High Purity	Kaolin	AZS	Mullite <sup>(2)</sup>
Color	White	Light Gray	White	White
Melting Point	3200°F (1760°C)	3200°F (1760°C)	3200°F (1760°C)	3400°F (1870°C)
Temperature Grade	2300°F (1260°C)	2300°F (1260°C)	2600°F (1430°C)	3000°F (1650°C)
Recommended Operating Temperature <sup>(1)</sup>	2150°F (1175°C)	2150°F (1175°C)	2450°F (1345°C)	2800°F (1540°C)
Specific Gravity	2.73 g/cc	2.67 g/cc	2.73 g/cc	3.0 g/cc

(1) The recommended operating temperature of Fiberfrax Products is determined by irreversible linear change criteria, not melting point.

(2) Fibermax mullite fibers are produced by the sol gel forming process.

## Chemical Composition

	High Purity	Kaolin	AZS	Mullite
Al <sub>2</sub> O <sub>3</sub>	47-52%	45-51%	29-31%	72-75%
SiO <sub>2</sub>	48-53%	46-52%	53-55%	25-28%
ZrO <sub>2</sub>			15-17%	
Fe <sub>2</sub> O <sub>3</sub>		<1.5%		
TiO <sub>2</sub>		<2%		
Na <sub>2</sub> O	<.5%	<.5%		

Data are average results of tests conducted under standard procedures and are subject to variation. Results should not be used for specification purposes.

## Typical Product Parameters

Computer-controlled furnacing technology at Unifrax allows for control of various product parameters. These parameters, such as diameter, settle volume<sup>(3)</sup> and fiber index, are critical to proper fiber selection. The following table details the product parameters for Fiberfrax Bulk Fibers:

### Typical Product Parameters

Fiber Class	Product	Chemistry	Chopping	Average Fiber Diameter	Fiber <sup>(4)</sup> Index%	Settle <sup>(3)</sup> Volume
7000 Series	Bulk 7000	High Purity	N/A	1.5 to 2.5 microns	45-55%	N/A
	7001-C-5	High Purity	Coarse	1.5 to 2.5 microns	45-55%	500
	7001-M-5	High Purity	Medium	1.5 to 2.5 microns	45-55%	300
	7001-F-5	High Purity	Fine	1.5 to 2.5 microns	45-55%	150
6000 Series	Bulk 6000	Kaolin	N/A	1.5 to 2.5 microns	45-55%	N/A
	6001-C-5	Kaolin	Coarse	1.5 to 2.5 microns	45-55%	500
	6001-M-5	Kaolin	Medium	1.5 to 2.5 microns	45-55%	300
	6001-F-5	Kaolin	Fine	1.5 to 2.5 microns	45-55%	150
	Bulk 8000	AZS	N/A	1 to 2 microns	45%	

(3) Settle Volume is a measurement used to indicate the physical dimensions (i.e., diameter, length) of a fiber. A larger number indicates the fiber has larger physical dimensions, such as diameter and/or length.

(4) Fiber Index is the percentage of fiberized material by weight in a fiber. Unfiberized material is called shot. (i.e., higher fiber index indicates a "cleaner" fiber). Fiber index is measured using the conical elutriation method. For questions regarding this testing, please contact Unifrax at 716-278-3800.



## Fiberfrax Specialty Fibers

In addition to Fiberfrax Bulk Fibers, Unifrax has the ability to produce many different specialty fibers that provide a variety of desirable performance properties for certain applications. These fibers can be classified into the following general categories:

- High-Index Fibers
- High-Temperature Fibers
- Large-Diameter Fibers
- Milled Fibers

### High-Index Fibers

Fiber index is a measurement which determines the amount of fiberized material in the actual fiber. During fiber manufacturing, shot or unfiberized material is produced as a natural product of the fiberization process. Unifrax has the ability to reduce the amount of shot in a fiber by controlling the furnacing process or by washing out the unfiberized material. As shown in the table on page 4, Unifrax offers several high-index fibers ranging in fiber index from 68% up to 95+%.

Fiberfrax High-Index Fibers have proven to be a good reinforcement material for use in automotive brake lining and other friction materials. These high-index fibers provide a variety of desirable properties such as:

- Frictional stability
- High-temperature frictional performance
- Fade resistance
- Flexural reinforcement

Fiberfrax High-Index fibers can also be used as a mechanical thixotrope in coatings applications offering reinforcement and fire resistance as additional benefits. These fibers offer the following unique properties:

- Excellent high-temperature stability
- Good strength and high modulus
- Low coefficient of thermal expansion
- Superior chemical resistance
- Very low moisture absorption

The thixotropic properties of Fiberfrax High-Index Fibers in conjunction with the mechanical and physical properties they have to offer make them an excellent candidate for use in:

- Mastics
- Adhesives
- Thick Film Coatings
- Fire Protective Materials
- Caulks, Putties, and Sealants

### Fiberfrax High-Temperature Fibers

Unifrax manufactures two high-temperature specialty fibers for use in applications beyond recommended operating temperatures of 2300°F (1260°C). Bulk 8000 is made from high-purity alumina, zirconia, and silica raw materials. This chemistry, along with the unique manufacturing process, provides a fiber which can withstand continuous operating temperatures up to 2450°F (1345°C).

Fibermax® Bulk Fiber is a high-temperature, polycrystalline mullite fiber. Fibermax fiber can withstand continuous operating temperatures up to 2800°F (1540°C) and is virtually shot free. Fibermax fibers can be blended with regular alumina-silicate Fiberfrax fibers to increase the thermal stability of the blended product beyond that of high-purity bulk fiber.

### Fiberfrax Large-Diameter Fibers

Unifrax has the ability to control the average fiber diameter of fibers through a unique spinning operation. It is this spinning operation that is used to produce both the Fiberfrax Spun Fiber and Long Staple Fibers. Average fiber diameters for these fibers range from 3 to 12 microns as detailed on the table below. These larger-diameter fibers provide certain desirable properties, such as:

- Excellent resistance to mechanical stress and vibration
- Reduced processing time in vacuum-forming operations
- Ability to produce lower-density vacuum-formed products

### Fiberfrax Milled Fibers

Fiberfrax Milled Fibers are ball milled from Regular Fiberfrax Fibers to reduce fiber length, thus increasing the flowability and facilitating its dispersion in a matrix, such as resins or refractory cement compositions. Fiberfrax Milled Fibers can also be used as a compact filler insulation. These milled fibers can be used as a functional additive in a variety of coatings and composites to provide the following benefits:

- Superior wear resistance
- Improved corrosion resistance
- Provides reinforcement and excellent compressive strength

## Specialty Fibers Typical Product Parameters

Fiber Class	Product	Chemistry	Chopping	Average Fiber Diameter	Fiber Index%
High-Index Fibers	Washed 657	High Purity	N/A	1 to 2.5 microns	70
	Washed 707	High Purity	N/A	1 to 2.5 microns	75
	Washed 757	High Purity	N/A	1 to 2.5 microns	80
	HS70	High Purity	N/A	1 to 2 microns	68
	HS70C	High Purity	Medium	1 to 2 microns	68
	HS95	High Purity	N/A	1 to 2.5 microns	95
	HS95C	High Purity	Medium	1 to 2.5 microns	95
	HSA-HP	High Purity	N/A	0.75 to 1.5 microns	95+
	HSA-K	Kaolin	N/A	0.75 to 1.5 microns	95+
High-Temperature Fibers	Bulk 8000	AZS	N/A	1 to 2 microns	45
	Fibermax Bulk	Mullite	N/A		95+
Large-Diameter Fibers	Long Staple Fine	AZS	N/A	4 to 8 microns	N/A
	Long Staple Medium	AZS	N/A	8 to 12 microns	N/A
	Spun	High Purity	N/A	3 to 5 microns	50
Milled Fibers	Ball Milled Fiber	High Purity	Milled	1 to 2 microns	50

For additional information about product performance or to identify the recommended product for your application, please contact the Unifrax Application Engineering Group at 716-278-3888.

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.

