
3M
Nextel™
Textiles
Ceramic fiber products for outerspace applications.

Physical Properties

3M™ Nextel™ Fabrics, Tapes, and Sleevings are designed to meet the toughest thermal, mechanical and electrical performance requirements, outperforming the useful limits of other high temperature textiles. Nextel 312 Ceramic Fibers and Nextel 440 Ceramic Fibers are continuous polycrystalline metal oxide fibers suitable for producing textiles without the aid of other fiber or metal inserts.

Cost Competitive Solution

Per square foot costs can be lower than competitive alternatives. Nextel quality and product lifetime add lasting value.

Low Shrinkage

Products fabricated from Nextel ceramic fibers exhibit very low shrinkage, providing excellent dimensional stability.

Abrasion Resistance

Nextel 312 fibers demonstrated excellent abrasion resistance after a 30 minute exposure at up to 2000°F (1093°C). Nextel 312 fibers lasted 2.5 to 5 times longer than leached glass in the Duplan Silk Abrasion Test.

Thermal Mechanical Properties

Products made with Nextel 312 and Nextel 440 ceramic fibers retain greater strength and flexibility at higher temperatures than other refractory textile materials.

Thermal Insulation Properties

Nextel fiber products have excellent resistance to thermal shock, have low thermal conductivity and can be fabricated into excellent high temperature thermal insulators.

Non-hygroscopic

Nextel 312 fiber's smooth, non-porous surface only gains 0.08% of its weight after 2 hours exposure to 100% humidity.

Nextel Textiles Meet NASA Requirements

- **Shuttle re-entry criterion is 2000°F for 9 minutes**
- **Shuttle launch criterion is 3000°F for 2-3 minutes**
- **Micrometeorite shield is for impact protection from outerspace debris**

Electrical Properties

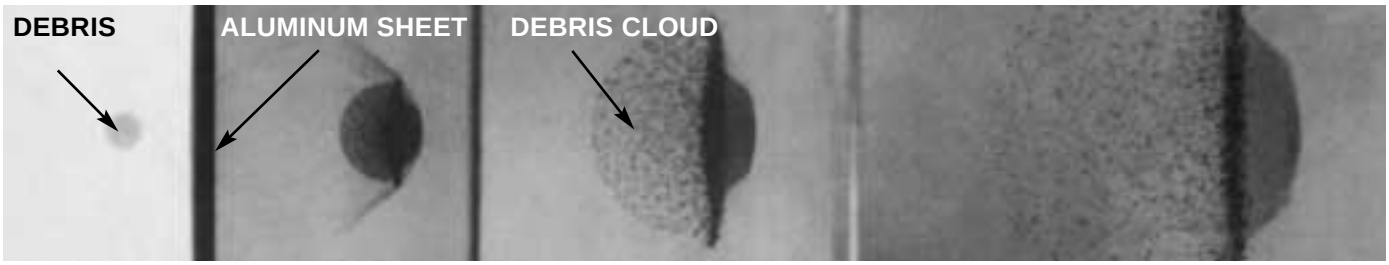
The Nextel fiber's high electrical resistance at elevated temperatures, low shrinkage and low moisture absorption characteristics make it excellent for high temperature electrical insulation applications. Nextel fibers contain no residual acids or chlorides to leach out and cause metal corrosion.

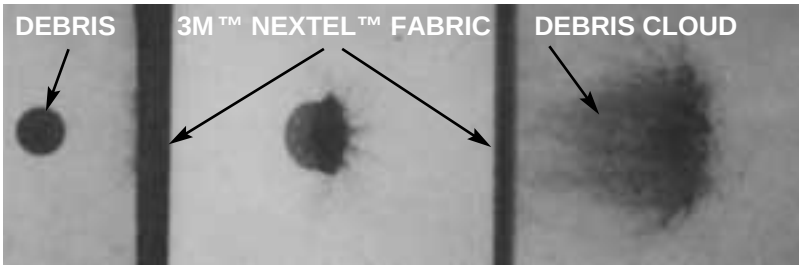
Nextel fibers have flown in space in the following applications:

- Exit cone
- Micrometeorite shield
- Booster access doors
- Whipple shield
- Door seals
- Gaskets
- Shuttle tiles

Top: *The Stuffed Whipple Shield offers greater protection and requires less space in protecting spacecraft from being disabled by collisions with space debris, similar to what is shown at left. The shield, produced at NASA Marshall Space Center in Huntsville, AL, and the Johnson Space Center in Houston, TX, contains 3M™Nextel™ Ceramic Fabric. Nextel was shown to be a key component in the development of this lightweight improvement to conventional shielding.**

*International Journal of Impact Engineering, Vol. 17, *Enhanced Meteoroid and Orbital Debris Shielding*., E. L. Christiansen, J. L. Crews-NASA Johnson, J. E. Williamsen, J. H. Robinson, A. M. Nolen-NASA Marshall.

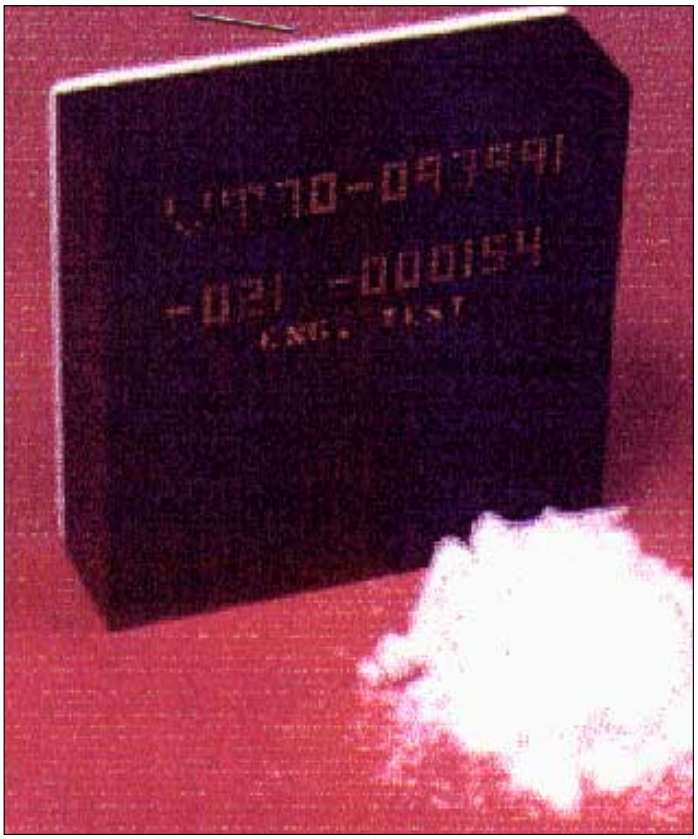




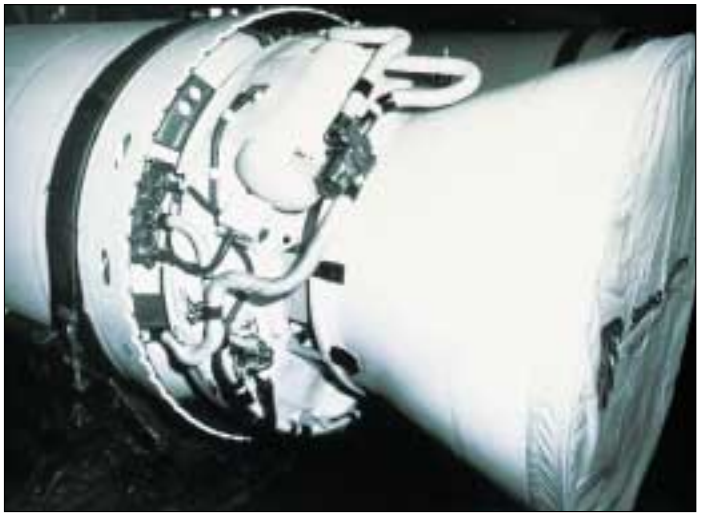
Above: *This sequence of high-speed x-ray photography shows the high velocity impact of a 3/8" (9.53 mm) aluminum projectile, penetrating a .2753" thick aluminum sheet. The projectile is traveling at 14,976 mph (6.7 km/sec). Space debris and micrometeorites are a significant threat to spacecraft and satellites.*

Left: *This series of x-ray images shows the debris cloud caused by the impact of a 3/8" (9.53 mm) aluminum projectile, penetrating two sheets of 3M™ AF-62 Nextel™ Fabric, spaced at 3" (7.62 cm). The projectile is traveling at 14,733 mph (6.59 km/sec). Protective devices for spacecraft and satellites, which contain Nextel ceramic fibers, offer weight and space advantages over traditional aluminum alternatives. The dispersion of debris has shown to better shock the projectile fragments and is better than aluminum alternatives at slowing debris cloud expansion, according to NASA data.*

X-ray photography and data was provided by NASA Marshall Space Center and have been published in NASA Contractor Report, 4707, *Formational and Description of Debris Clouds produced by Hypervelocity Impact*, February 1996. A. J. Pikutowski, University of Dayton Research Institute.



3M™ Nextel™ Ceramic Fibers are used in reusable blankets and tiles for the space shuttle. Nextel is also used as a gap filler between tiles helping to minimize thermal exposure to underlying structure.



Top: *3M™ Nextel™ Ceramic Fibers and Fabrics have been used by NASA and other aerospace manufacturers, to achieve their goals of performance and value. Examples include many space shuttle applications such as inclusion in the underbody tiles, gap fillers, gaskets and seals. The lightweight and durable fabrics allow design engineers to meet or exceed their specifications.*

Lower: *In the Delta II rocket, 3M™ Nextel™ Ceramic Fabrics were sewn into blankets to protect the liquid engine from the plume of the solid boosters. Easily sewn into blankets or other configurations, Nextel ceramic fabrics can solve many problems. Silicone coatings can easily be applied to Nextel fabrics, helping protect against environmental factors.*

The Minuteman rocket is an example where flexibility and high temperature requirements were necessary. Braided 3M™ Nextel™ was used to protect pressurized gas lines against the heat and flames resulting from rocket plume.

Property	Units	3M™ Nextel™ 312	Nextel 440	Nextel 550	Nextel 610	Nextel 720
Use Temperature	—	2200°F	2500°F	2200°F	2200°F	2200°F
Filament Diameter	µm	10-12	10-12	10-12	10-12	10-12
Crystal Size	nm	<500	<500	<500	<500	<500
Crystal Type		$9Al_2O_3:2B_2O_3$ + amorph. SiO_2	gamma Al_2O_3 + mullite + amorph. SiO_2	gamma/delta Al_2O_3 + amorph. SiO_2	alpha Al_20_3	alpha Al_2O_3 + mullite
Density	g/cc	2.70	3.05	3.03	3.88	3.40
Filament Tensile Strength (51mm gage)	MPa	1700	2000	2000	2930	2100
Filament Tensile Modulus	GPa	150	190	193	373	260
Surface Area	m^2/g	<.2	<.2	<.2	<.2	<.2
Composition	wt%	62 Al_2O_3 24 SiO_2 14 B_2O_3	70 Al_2O_3 28 SiO_2 2 B_2O_3	73 Al_2O_3 27 SiO_2	>99 Al_2O_3 .2-.3 SiO_2 .4-.7 FeO_3	85 Al_2O_3 15 SiO_2
Thermal Expansion (100-1100°C)	ppm/°C	3 (25-500°C)	5.3	5.3	7.9	6.0
Dielectric Constant	(@ 9.375 Ghz)	5.2	5.7	~5.8	~9.0	~5.8

3M is a technology leader in providing advanced ceramic materials for high temperature applications. Discover how our products can expand your design capabilities to meet new performance requirements.

3M

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