

# NICALON™ CERAMIC FIBER

COI Ceramics, Inc. (COIC) is a leading supplier of ceramic reinforcements and ceramic matrix composites (CMC). COIC began operations in 1999 and employs a highly technical staff with extensive experience and knowledge in high performance ceramics. Our San Diego, California facility manufactures CMC's while our Salt Lake City, Utah facility serves as a worldwide fiber distribution and technical support center. For more information on ceramic fiber capabilities and cost, contact our technical staff at (801) 251-8111 or, (801) 251-8049 or browse the web at [www.coiceramics.com](http://www.coiceramics.com). Send written requests to 7812 West 4100 South, Magna, Utah 84044.

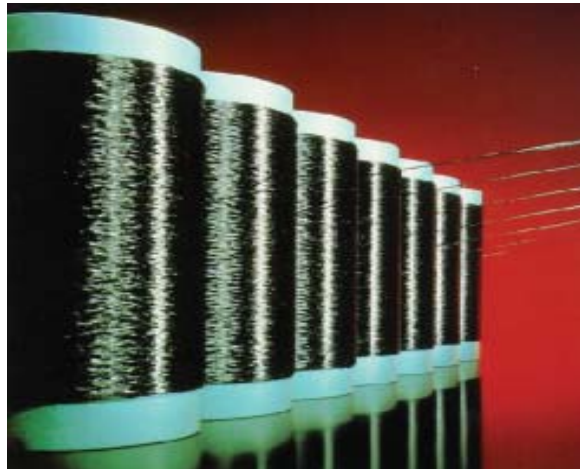
## GENERAL DESCRIPTION

NICALON™ ceramic fiber is a multi-filament silicon carbide-type fiber manufactured by Nippon Carbon Co., Ltd. of Japan. The fiber is homogeneously composed of ultra-fine beta-SiC crystallites and an amorphous mixture of silicon, carbon, and oxygen. The fiber has excellent strength and modulus properties for ceramic fibers, and retains its properties at high temperatures. NICALON™ is highly resistant to oxidation and chemical attack.

NICALON™ is available in a wide variety of electrical grades, product forms, and surface treatment options, depending on the intended use. Typical properties are shown in Table 1.

## USES

NICALON™ ceramic fiber can be used as a reinforcement for plastic, ceramic, and metal matrix composites to produce high performance composite



materials. Surface treatments are normally recommended to facilitate processing and maximize composite properties.

NICALON™ can also be used to form fibrous products such as high temperature insulation, filters, etc. Its resistance to chemical attack allows it to be used in harsh environments.

## GRADES

NICALON™ ceramic fiber is available in two primary grades, differentiated by electrical properties. Other electrical grades, such as low volume resistivity are also available. Contact COI Ceramics to discuss specific needs.

### *Ceramic Grade (CG) NICALON™*

The standard grade of the NICALON™ product line; offers the optimum mechanical properties and high-temp performance for most applications.

### *HVR Grade NICALON™*

A low dielectric (high volume resistivity) fiber that is designed to offer an optimum balance of mechanical and electrical properties in dielectric structures.

## PRODUCT FORMS

NICALON™ ceramic fiber is available in several physical forms and with several surface treatment options, to offer the maximum application flexibility.

### *Continuous Fiber*

Supplied as multi-filament tow, spooled on 3 inch ID bobbins to 500 meters in length (100 grams in weight). Also available in random lengths at a reduced price.

### *Woven Cloth*

Available in three weave styles as shown in Table 2. Woven cloth is typically supplied as 1-meter-wide continuous rolls of specific lengths. Other weave or braid styles can be made available. Contact COI Ceramics to discuss specific needs.

### *Chopped Fiber*

Available of 1-mm length chopped multi-filament tow. Longer lengths also available. Contact COI Ceramics to discuss specific needs. Packaged as 3 kg containers.

### *Felt / Mat*

Random lengths of NICALON™ ceramic fiber in a PVA binder. Customizable areal weights, shapes and sizes. Contact COI Ceramics to discuss specific needs.

## HOW TO USE

### Polymer Matrix Composites

NICALON™ family of products is suitable for incorporation into standard resin prepreg, using conventional prepreg techniques. Unidirectional or oriented prepreg can be produced using continuous fiber, or woven cloth, respectively. Special fiber surface treatments (see Table 3) are normally recommended to maximize fiber property translation into the composite and to afford superior retention of composite properties under hot-wet conditions. Resin systems can include the entire line of thermosets and thermoplastics.

### Ceramic Matrix Composites

NICALON™ can be incorporated as the reinforcing phase for a variety of ceramic composites. Standard CMC processing techniques, such as sol-gel, chemical vapor infiltration, melt infiltration or polymer infiltration can be used, depending on the users needs and capabilities. Candidate matrix materials include silicon carbide, silicon nitride, alumina, glasses, and others. Fiber surface treatments are generally removed before making CMC's, such as by heating to 600C for 30 minutes. Fiber interface coatings, such as BN, are recommended to achieve optimum CMC properties. The specific grade of Nicalon and the specific processing technique is best determined by the user.

### Metal Matrix Composites

Chopped, woven, or continuous NICALON™ ceramic fiber can serve as a reinforcing phase in MMC's. The

specific grade of Nicalon and the specific processing technique is best determined by the user.

### Weaving, Braiding, and Coating

As a textile grade yarn, NICALON™ can be readily incorporated into a large variety of woven tapes, braides, etc. Specialty interface coatings such as BN (often required for optimum CMC mechanical properties) may be applied to the tow or cloth. A network of US contractors exists to respond to customer needs. Contact COI Ceramics to discuss specific needs and receive further information.

### AVAILABILITY & ORDERING

NICALON™ ceramic fiber is available exclusively in North America from COI Ceramics, Inc. For more information, contact the COI Ceramics, Magna, UT Sales & Customer Service Office at 801-251-8111.

### LIMITED WARRANTY

COI Ceramics believes that the information contained herein is an accurate description of the typical properties and uses of the products, but it is your responsibility to test the material to determine its performance and safety for your application.

COIC's sole warranty is that the product meets current sales specs. Specification writers should contact COIC for sales specifications. COIC specifically disclaims any other express or implied warranty.

**TABLE 1: TYPICAL PROPERTIES at RT**

	Ceramic Grade	HVR Grade
Fiber Denier	1800	1800
Density, g/cc	2.55	2.32
Composition, wt.% Si:C:O	57:32:12	57:32:12
Filaments per Tow	500	500
Filament Diameter, um	14	14
Tensile Strength, GPa	3.0	2.8
Tensile Modulus, GPa	210	180
Vol. Resistivity, ohm-cm	10 <sup>3</sup>	>10 <sup>6</sup>
Dielectric Constant	9.2	6.4
Loss Factor	1.0	0.05
CTE, ppm/C, 0-900C	3.9	3.9
Thermal Conductivity, W/m.K		
At 25C	2.97	
At 500C	2.20	
Specific Heat, J/g.K		
At 25C	0.71	
At 500C	1.17	

**TABLE 2: STANDARD WEAVE SIZES**

Weave Style	Yarn Count (ends/inch) (warp x fill)	Arial Weight (for CG)
Plain Weave (PW)	16 x 16	250 g/m <sup>2</sup>
5 Harness Satin (5HS)	16 x 16	250 g/m <sup>2</sup>
8 Harness Satin (8HS)	22 x 22	380 g/m <sup>2</sup>

**TABLE 3: SURFACE TREATMENT OPTIONS**

Designation	Type	Intended Use*
M Sizing	Poly-vinylacetate	CMC, MMC
PVA Sizing	Polyvinyl Alcohol	CMC, MMC
P Sizing	Modified Epoxy	PMC
DCC-2 Sizing	Proprietary	PMC, TS, TP

\* PMC = polymer matrix composite, CMC = ceramic matrix composite, MMC = metal matrix composite, TS = thermoset, TP = thermoplastic

### CERAMIC FIBER - CONTACTS:

Hugh Spilker, Engineer  
PH:801.251.8111,FX:801.251.8031  
Mobile: 858.922.0877  
Hugh.Spilker@atk.com

Jay Curtis, Manager  
PH: 801.251.8049, FX: 801.251.8031  
Mobile: 619.993.3009  
JayA.Curtis@atk.com