

# Hi-Nicalon™ Type S

## GENERAL DESCRIPTION

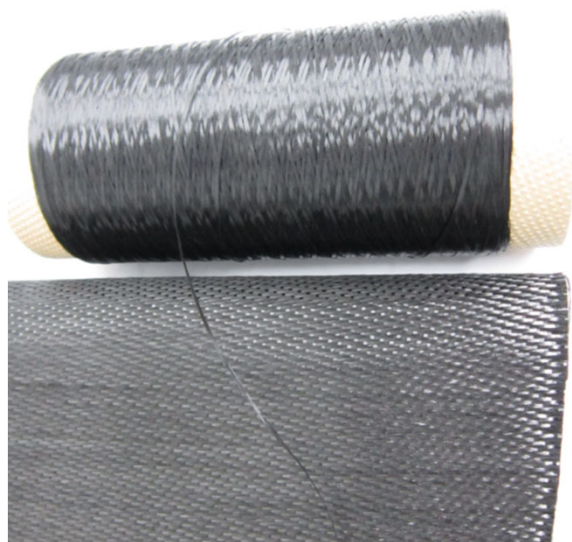
**HI-NICALON™ TYPE S** ceramic fiber is a multi-filament silicon carbide-type fiber manufactured by NGS Advanced Fibers Co., Ltd. (NGS) of Japan. NGS is known worldwide as the leading manufacturer and innovator of multi-filament silicon carbide-type fibers.

**HI-NICALON™ TYPE S** is a stoichiometric beta-SiC fiber manufactured near-oxygen-free using de-carbonization pyrolysis and electron-beam curing. It has higher modulus, creep resistance and oxidation resistance than Hi-NICALON™.

**HI-NICALON™ TYPE S** is highly resistant to oxidation and chemical attack and is available in a variety of product forms, depending on the intended use.

## USES

**HI-NICALON™ TYPE S** ceramic fiber is primarily designed to be used as reinforcements for high temperature ceramic composites. It can also be used as a reinforcement for plastic, and metal matrix composites. Surface treatments are normally recommended to facilitate processing and maximize composite properties. The fiber can also be used to form fibrous products such as high temperature insulation, filters, etc. Its resistance to chemical attack allows the fiber to be used in harsh environments. Typical fiber properties are shown in Table 1.



## PRODUCT FORMS

**HI-NICALON™ TYPE S** ceramic fiber is available in several physical forms to offer the user application flexibility. The fiber is coated with polyvinyl alcohol (PVA) sizing for improved handle ability.

### Continuous Fiber

Supplied as multi-filament tow, spooled on 3 inch ID bobbins to 550 meters in length (104.5 grams/spool). Also available in random lengths at a reduced price.

### Woven Cloth

Available as 5HS Weave or 8HS Weave, as identified in Table 2, **HI-NICALON™ TYPE S** cloth is supplied as 1 meter-wide continuous rolls of specific lengths. Other widths, weave or braid styles can be made available. Contact COI Ceramics to discuss specific needs.

## HOW TO USE

### Ceramic Matrix Composites

**HI-NICALON™ TYPE S** fiber can be incorporated as the reinforcement 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 user's needs and capabilities. Candidate matrix materials include silicon carbide, silicon nitride, alumina, glasses, and others. Fiber surface treatments are generally removed before making CMCs, such as by heating to 600°C for 30 minutes. Fiber interface coatings, such as BN, are generally applied to the fiber to achieve optimum CMC properties. The specific fiber type and the specific CMC processing technique is best determined by the user.

*COI Ceramics, Inc., offers a variety of advanced ceramic products that are engineered to meet the demanding requirements of high-temperature applications. See the COI Ceramics website for a complete review of the materials solutions available for your applications.*  
www.coiceramics.com

## Polymer or Metal Matrix Composites

Please contact COI Ceramics for additional information on Nicalon™ ceramic fiber, which is well suited for PMC and MMC applications

## Weaving, Braiding, and Coating

As textile grade yarns, **HI-NICALON™ TYPE S** fiber can be readily incorporated into a large variety of woven tapes, braids, etc. Specialty interface coatings such as BN (often recommended for optimum CMC mechanical properties) may be applied to the tow or cloth. A number of US vendors exist to respond to customer needs. Contact COI Ceramics to discuss specific needs and receive further information.

## SPECIAL PROPERTIES

CMCs reinforced with **HI-NICALON™ TYPE S** ceramic fiber offers distinct advantages over other materials. Oxide fiber and super alloys generally lose mechanical properties above 800°C. SiCO fiber generally loses properties above 1000°C. 100 micron diameter monofilament SiC fiber is generally not possible to weave. **HI-NICALON™ TYPE S** ceramic fiber overcomes these drawbacks.

There are two versions of Hi-Nicalon™ Type S that are designated "Hi-Nicalon™ Type S (**NOX**)" and "Hi-Nicalon™ Type S (**OX**)". The **OX** version of the fiber has had the thin residual carbon surface layer removed by **OX**idation. The **NOX** version of the fiber (**Not OX**idized) retains the carbon surface layer. The presence or absence of the carbon layer can change the subsequent performance of the fibers. There can be a slight degradation of fiber properties for the **OX** fibers, but removal of the carbon can ultimately result in better CMC properties since the carbon is not subject to oxidation during processing or use.

## AVAILABILITY & ORDERING

**HI-NICALON™ TYPE S** 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.

## SAFE HANDLING INFORMATION

Product safety information required for safe use is NOT included. Before handling, read the product Safety Data Sheet (SDS) which is available from COI Ceramics.

## LIMITED WARRANTY

COI Ceramics (COIC) believes that the information contained herein is an accurate description of the typical properties and uses of the products, but it is the customer's 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 ROOM TEMPERATURE**

Fiber Denier		1800
Density	g/cc	2.91
Composition	wt% Si:C:O	31:00.2
C/Si Atomic Ratio		1.05
Tex	g/km	190 - 210
Tensile Strength	GPa	≥ 2.55
Tensile Modulus	GPa	≥ 340
Oxygen Content	wt%	≤ 1
Sizing Amount	wt%	0.5 - 2.0

**TABLE 2: STANDARD WEAVE CONFIGURATIONS**

Weave Style	Yarn Count (warp x fill), (epi)	Areal Weight (g/m <sup>2</sup> )
5 Harness Satin (5HS)	16 x 16	250 - 300
8 Harness Satin (8HS)	22 x 22	340 - 400