

# SPECIALTY MATERIALS, INC.

Manufacturers of Boron and SCS Silicon Carbide Fibers and Boron Nanopowder

## Testing of SCS-6 Fibers

The SCS-6 silicon carbide monofilament was initially developed for use as the reinforcement in metal matrix composite applications. Since these applications were anticipated to be in Aerostructures and gas turbine engines, a fiber quality system consistent with the requirements of these industries was established. The following is a brief description of the traceability and testing system for SCS-6 fiber.

SCS monofilament substrate –

A 33-micron diameter, pitch-based carbon monofilament is spun, heat treated, back-wound onto spools and released to SCS fiber production for use as the silicon carbide deposition substrate. Each of these substrate spools is traceable to a unique spinning/heat treatment package and pitch production batch. Process conditions and control test results are recorded for batch, package and spool stages of production.

SCS-6 silicon carbide monofilament –

A silicon carbide reactor run is defined as a continuous deposition run length of monofilament from a single reactor. Each reactor run is assigned a bar-coded serial number and is tracked through the production process and testing stations. The carbon monofilament spool number used for the reactor run is entered into the database.

During reactor startup of every run the fiber diameter and strength are tested by reactor operators and used to establish that minimum properties have been met prior to production initiation. Although these values are entered into production log sheets, they do not end up in the reactor run database. At the end of a reactor run (this is end of the first pass of coating), the fiber spool is tested for diameter and strength and the values are entered into the run's database. The fiber run is then "second-pass" coated. Shortly after initiation of this second pass a length of fiber is removed and reserved as a sample of "end-of-run" double-pass coating. At the completion of the second pass run (the beginning of the original run) the spool is sent to Testing for diameter and strength testing. Another fiber sample is taken for "beginning-of-run" final coating thickness. The beginning and end of second pass samples are then checked for coating thickness on a scanning electron microscope. The minimum coating thickness requirement for SCS-6 fiber is 3 microns. On a 10% sampling basis reactor runs are tested for modulus. Spools are then rewound into finished packages. During the rewind process continuous diameter traces can be generated. These traces can be made available if requested.

Test descriptions -

**Diameter measurements** are made by removing one or two six-inch fiber samples from a 25-foot length of fiber. The fiber is put between the transmitting and receiving lenses of a laser

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micrometer. The readings must be between 0.00540" and 0.00580" or they are rejected. The diameter value obtained is entered into the database for the reactor run spool.

**Tensile strength** is measured by using an Instron Universal Testing Machine with flat faced pneumatic grips and a Series IX computerized data acquisition system. The following is the test procedure used:

Set the following test parameters on the universal test system:

Cross Head Speed:	0.5 in/min (automatically set by the system)
Jaw Pressure:	60 psig
Grip Distance (gage length):	1 inch

Upon implementation of the computerized test method, the barcode label on the spool is scanned. The required information for the fiber spools is displayed. The average measured diameter is used as the diameter for all tensile tests performed on the respective spool. Aluminum foil is installed on the flat grip pad. This foil is replaced after ten pulls or if it has been damaged in any way. Ten fiber specimens six inches long are prepared for testing. Each fiber test specimen is positioned in the grip assuring proper alignment. All test results are automatically entered into the database. In the event of a grip induced failure, a replacement specimen is tested and the data from the flawed test deleted. If there is no apparent test-related cause for a low value it is considered to be a valid test. If the average strength value for the ten pulls is less than 500 ksi the spool is failed and submitted for retest.

**Modulus measurements** are performed on an Instron Universal Testing Machine with flat faced pneumatic grips and a Bluehill computerized data acquisition system using the following procedure:

Set the following test parameters on the universal test system:

Bluehill Test Method:	SCS-6
Cross Head Speed:	0.5 in/min and 1 in/min (automatically set by the system)
Jaw Pressure:	60 psig
Grip Distance (gage length):	12 inches

Upon implementation of the computerized test method, the barcode label on the spool is scanned. The required information for the fiber spools is displayed. New aluminum foils are installed on the grips. Foil is replaced after five pulls or if it has been damaged in any way. Five fiber specimens approximately eighteen inches long are prepared for testing. Each fiber test specimen is positioned in the grip assuring proper alignment. The modulus test is performed and repeated for the remaining samples. In the event of a grip induced failure, a replacement

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specimen is tested and the data from the flawed test deleted. If there is no apparent test-related cause for a low value it is considered to be a valid test. If the average modulus value for the five pulls is less than 50.3 Msi, then the spool is failed and submitted for retest.

**Loop testing** is an additional test performed to insure adequate fiber handleability:

A convenient length (approx. one foot) fiber sample is removed from the fiber spool. The fiber sample is looped over itself to form a loop approximately one inch in diameter. Using a tapered mandrel having marked diameter sections, the loop is lowered over the largest mandrel step (14mm) and gently tightened on the mandrel. This procedure is repeated for each smaller step until the specimen fractures. Fracture at a diameter greater than 14mm is considered a failure and requires submission for retest. The pass/fail result is noted on the spool label.