



Document No.: NMS 818

NCAMP Material Specification

Carbon Fiber Tow

Prepared by: Yeow Ng, John Tomblin

Reviewed by: Mohamed Abdallah (consultant), Debbie Davis (Cytec), Steve Ellery (Hexcel), Mike Kinsella (Toho Tenax), Axel Leuchter (Toho Tenax), David Lynch (Hexcel), LaRhea McBee (Hexcel), Joel Payne (Toho Tenax), Dusty Penn (ACG), Mike Stuart (Cytec), Bob Varga (Toho Tenax)

TABLE OF CONTENTS

1. SCOPE	4
1.1 Form	4
1.2 Application.....	4
1.3 Classification: This specification consists of the following Styles and Grades	4
1.4 Safety – Hazardous Materials.....	5
1.5 Rounding of Significant Value	5
1.6 Detail Specification	5
1.7 Qualified Products	5
2. APPLICABLE DOCUMENTS.....	5
2.1 ASTM Publications:.....	5
2.2 Occupational Safety and Health Administration (OSHA) Publications	6
2.3 SACMA Publications:.....	6
2.4 American Society for Quality Publications:.....	6
2.5 NCAMP Publications:.....	6
3. TECHNICAL REQUIREMENTS	6
3.1 Detail Specifications	6
3.2 Material.....	6
3.3 Properties	8
3.4 Qualification	9
4. QUALITY ASSURANCE AND CERTIFICATION DOCUMENTATIONS.....	11

- 4.1 Responsibility for Inspection 11**
- 4.3 Acceptance Sampling Plan 12**
- 4.4 Change Control Approval..... 12**
- 4.5 Test Methods 13**
- 4.6 Records..... 14**
- 4.7 Criteria for Retesting/Obviation 14**
- 4.8 Quality System 14**
- 4.9 Product Key Characteristics and Statistical Process Control 14**
- 5. PREPRATION FOR DELIVERY 14**
- 5.1 Identification on Spool Core 15**
- 5.2 Identification on Packaging..... 15**
- 5.3 Certificate of Conformity and Test Results..... 15**
- 6. ACKNOWLEDGEMENT 16**
- 7. REJECTION 16**
- 8. DEFINITIONS 16**

1.4 Safety – Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.5 Rounding of Significant Value

For purposes of determining conformance with this specification (specified limits or requirements contained within this specification), an observed value or a calculated value shall be rounded “to the nearest unit” in the last right-hand digit used in expressing the specification limit, in accordance with the rounding method of ASTM E 29.

1.6 Detail Specification

This base specification contains basic precursor and carbon fiber requirements that apply to every product. The detail specifications contain additional or superseding properties and requirements that apply to a specific product.

1.7 Qualified Products

This specification requires qualified products. The carbon fiber tow product shall be qualified concurrently with a specific resin in a composite material form in accordance with 3.4. The carbon fiber tow product shall be produced in accordance with an NCAMP approved Process Control Document (PCD). The PCD shall be prepared in accordance with NCAMP’s NRP 102 Polyacrylonitrile-Based Carbon Fiber Process Control Document (PCD) Preparation and Maintenance Guide.

2. APPLICABLE DOCUMENTS

The following publications form a part of this specification to the extent specified herein. The latest issue of the NCAMP and SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order unless otherwise specified. When a referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ASTM D 1423	Standard Test Method for Twist in Yarns by Direct-Counting
ASTM D 4018	Standard Test Methods for Properties of Continuous Filament Carbon and Graphite Fiber Tows
ASTM D 6156	Standard Practice for Use of Reversed-Phase High Performance Liquid Chromatographic Systems

ASTM E 29 Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 Occupational Safety and Health Administration (OSHA) Publications

Available from U.S. Department of Labor, Bureau of Labor Standards,

<http://www.osha.gov/>

29CFR-1910.1200 Hazard Communication

2.3 SACMA Publications:

Available from Composites Fabricators Association (CFA), 1010 North Glebe Road, Suite 450, Arlington, VA 22201 (<http://www.acmanet.org>).

SRM 12R-94 SACMA Recommended Method for Lot Acceptance of Carbon Fibers

shelf life requirements. PAN lots blending requirements shall be provided in the applicable detail specifications.

3.2.2 Fiber Surface Treatment

Carbon fiber tow may be surface treated to enhance the fiber/matrix interface of the composite material. The surface treatment methods and levels, if used during material qualification program, shall be considered an integral part of the qualified product and can not be changed without prior approval from NCAMP.

3.2.3 Sizing

Sizing may be applied to the fiber during manufacture to improve the handling properties and adhesion to the matrix systems during subsequent processes. When applied, any sizing shall be applied in a continuous process throughout the carbon fiber lot production and shall be considered an integral part of the qualified product. Sizing type, sizing level, and drying methods cannot be changed without prior approval from NCAMP.

3.2.4 Twist

Carbon fiber tow twist shall be considered an integral part of the qualified product and cannot be changed without prior approval from NCAMP. Permissible level of twist for NT, TT, ST, and UT is specified in applicable detail specifications.

3.2.5 Splices

Carbon fiber tow splice requirements shall be given in the detail specification. If no requirement is given in the detail specification, no tow splicing shall be allowed. The tow splicing process and equipment shall be specified in the PCD.

3.2.6 Re-spooling

Carbon fiber tow re-spooling requirements shall be given the PCD. If no reference is made in the PCD, no re-spooling shall be allowed. Re-spooling procedures, equipment, additional tests, and inspection frequency shall be documented in the PCD. When

C266 Tdpc) eapv (te) sarnouffortj-3.00larate-Tc 0.0042 Tw 15.0655 -1.1(io8-e given 0.icsi

3.2.8 Workmanship

Carbon fiber tows shall be uniform in quality and condition, and free from cut or broken fibers, foreign material, and defects. A small amount of broken filaments and fuzz is common and acceptable; however, the carbon fiber shall not exhibit characteristics detrimental to weaving, resin impregnation, or structural properties. Winding shall be uniform and provide for proper unreeling and twisting. Transition materials produced in non-steady-state conditions, such as those during start-ups or interruptions, shall be discarded; transition materials shall not be certified to this specification.

3.2.9 Storage Life (Sized Fiber Only)

Storage life and conditions (temperature and humidity) for sized fiber shall be as specified in the detail specification. Any deviations from the shelf life shall be included in the procuring organization purchase contract. Measurement of storage life begins on the date (or month) that the sizing is applied to the carbon fiber tow and ends on the date (or month) the fiber or woven fabric is impregnated with resin. Sized carbon fiber tow product that exceeds the storage life is subject to rejection. Storage life extension, if permitted, is specified in the applicable detail specifications.

3.2.10 Carbon Fiber Lot (definition)

Carbon fibers formed during one essentially continuous, uninterrupted production run under the same steady-state process conditions using one to three PAN precursor lots. An interruption in the process of up to 72 hours is permitted, provided that the production equipment settings are not modified or another material was not produced on the equipment during the interruption. Deviation from this definition, if any, shall be documented in applicable detail specification.

3.3 Properties

The carbon fiber tow product shall be tested as outlined in Table 1. Testing shall be performed on the carbon fiber lot supplied and in accordance with specified test methods. Specific product requirements such as those related to lot averages and individual spools shall be as specified in the applicable detail specification. Additional fiber tow properties such as thermal and electrical properties, if required, will be specified in the applicable detail specifications.

Table 1 – Carbon Fiber Tow Properties

Paragraph

Property

3.3.4	Density	4.5.2
3.3.5	Mass Per Unit Length	4.5.3
3.3.6	Twist (see Note 1)	4.5.4
3.3.7	Sizing Content	4.5.5

Note 1: Twist test is optional for NT tow in lot acceptance test.

3.4 Qualification

3.4.1 General

Manufacturers seeking qualification shall comply with the requirements of this base specification and the applicable detail specification. The carbon fiber tow product shall be qualified concurrently with a specific resin (usually in the form of a prepreg) in accordance with the applicable NCAMP prepreg qualification test plan and the applicable composite material specification. The manufacturer shall establish a PCD for the manufacture of qualification carbon fiber material and maintain the PCD under revision control thereafter in accordance with NRP 102. Manufacturers seeking qualification shall provide NCAMP with the following carbon fiber tow product information:

Manufacturer Name and Address

Carbon Fiber Manufacturing Plant Address and Manufacturing Line(s)

Carbon Fiber Distributor Name and Address (if different from manufacturer)

Product Designation

MSDS (Material Safety Data Sheet (MSDS) meeting OSHA requirements, or recognized equivalent requirements for deliveries in overseas regions such as

3.4.3 Historical Data

Manufacturer shall provide a summary of historical fiber data as specified in Table 1 to demonstrate that the product being considered for qualification is an established product manufactured using a stable process. Such data should include the product properties variations between lots, between doffs of the same lot, and product(s) processes capability performance indices. These data along with the composite material qualification results will also be used to establish the acceptance limits of the fibers.

3.4.4 Baseline Carbon Fiber Tow Data

The manufacturer shall perform baseline carbon fiber tow tests to document the detailed characteristics of the carbon fiber being qualified. Ideallyyaceen c ,

The applicable detail specifications contain the specification limits for each property. When setting specification limits (also known as acceptance limits) for tow tensile strength and tow tensile modulus, consideration shall be given to historical fiber tow properties, fiber tow properties used in the prepreg qualification program, and acceptance limits of the lamina tensile properties. When setting specification limits for other properties, consideration shall be given to historical fiber tow properties and fiber tow properties used in the prepreg qualification program.

4.3 Acceptance Sampling Plan

The samples must be taken to be representative of the width of the production line or taken randomly from various creel or winder positions, as specified in the PCD.

The samples must be taken to be representative of the entire time of the production lot run. For scheduled doffing, the number of samples per doff is usually determined by the estimated number of doffs for the production lot. For continuous doffing, samples are usually taken based on fixed time periods.

The sampling plan (e.g. sample size) for acceptance testing per 4.2 shall be on lot-by-lot basis in accordance with one of the following:

- a) SACMA SRM 12R-94, Level 1 – Certified Products (when production time exceeds 30 days, add one sample for every 14 hours of operation),
- b) One which conforms to ANSI/ASQ Z1.4 or ANSI/ASQ Z1.9 at Acceptable Quality Limit (AQL) of 1 percent with product unit as specified in PCD, or
- c) One which conforms to DIN ISO 3951 at Acceptable Quality Limit (AQL) of 1 percent with product unit as specified in PCD.

4.4

July 2, 2009

NMS 818 Rev -

4.6 Records

The manufacturer shall keep the following records on file, for each fiber lot, for a period of at least 7 years from the date of manufacture, unless otherwise specified on the purchase order.

- a) Full fiber lot traceability. This traceability shall extend to the PAN lot and doff numbers (where applicable) used in the carbon fiber lot manufacture.

5.1 Identification on Spool Core

The following information shall be permanently and legibly marked on each spool core of tow:

- a) Manufacturer name
- b) Manufacturer product designation, including filament count, surface treatment, and sizing designation, if any
- c) Net weight (optional to mark on the container only)
- d) Tow length (optional to mark on the container only)
- e) Spool and doff numbers, if applicable (optional to mark on the container only)
- f) Fiber lot number
- g) Any additional labeling as necessary in accordance with OSHA 29CFR-1910.1200 or recognized equivalent requirements for deliveries in overseas regions such as EU Commission Regulation 2006/121/EC or GHS (JIS Z 7251).

5.2 Identification on Packaging

Packaging shall be capable of protecting the product during shipment and storage and will retain the properties required by this specification. Each container shall be permanently and legibly marked with the following information:

- a) NMS 818/"X" Rev. "Y" (where "X" is the detail specification number and "Y" is the detail specification revision level)
- b) Purchase order number
- c) All the identifications in section 5.1, except individual spool and doff numbers are optional
- d) Date of manufacture and/or expiry date, which may be coded in the lot number.
- e) Any additional labeling as necessary in accordance with OSHA 29CFR-1910.1200 or recognized equivalent requirements for deliveries in overseas regions such as EU Commission Regulation 2006/121/EC or GHS (JIS Z 7251).

5.3 Certificate of Conformity and Test Results

The manufacturer shall provide a certificate of conformity with each shipment as follows:

- a) A statement that "This production lot was sampled, tested, and certified in accordance with NMS 818/"X" Rev. "Y" (where "X" is the detail specification number and "Y" is the detail specification revision level)
- b) Test results in accordance with 4.2.2, sampled in accordance with 4.3.

6. ACKNOWLEDGEMENT

A material manufacturer should mention this specification number and the applicable detail specification number in all quotations and when acknowledging purchase orders.

- dd. Transition material: Material which is removed from the line during non-steady-state production because of process interruptions or start-up.
- ee. Twisted tow: Tow with intentional twist in its final form; denoted by the symbol "TT" or "ST"
- ff. Untwisted tow: Previously twisted tow that has had its twist removed in its final form; denoted by the symbol "UT."
- gg. Winders: Equipment used to collect the carbon fiber on the spool cores at the end of the carbon fiber conversion processes (end of the carbon fiber line). Also known as take-up winders.