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### NCAMP Material Specification

*This specification is generated and maintained in accordance with NCAMP  
Standard Operating Procedures, NSP 100*

High Toughness and High Tensile Performance Epoxy Prepregs,  
Type 33.5, Class 1, Form 3 (0.25-inch Width), Grade 192

Toray Composite Materials America, Inc. 3960 T1100GC 24K 71E 0.25-inch Slit  
Tape

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## REVISIONS:

Rev	By	Date	Pages Revised or Added
-	Vinsensius Tanoto	2/27/2024	Initial Release
A	Shakya Liyanage and Vinsensius Tanoto	3/5/2024	Updated cover page, addition of ATLAS logo.  Cover page: <ul style="list-style-type: none"> <li>Updating distribution statement from “Distribution Statement: This document is intended for proprietary use and will be distributed at the discretion of NIAR until such a time that it is decided the data and reports can be released for public distribution.” to “Distribution Statement A. Approved for public release; distribution is unlimited.”</li> </ul>
B	Vinsensius Tanoto	12/6/2024	<ul style="list-style-type: none"> <li>Added “John Tomblin” under “prepared by”.</li> </ul> Section 3.5.3: A few typos were updated. <ul style="list-style-type: none"> <li>Tension Modulus was revised from “22.98 to 20.13” to “22.55 to 26.79”</li> <li>SBS Min. Ind was revised from “15.7” to “13.7”</li> <li>SBS Average was revised from “13.7” to “15.7”</li> <li>Updated cover page, added “John Tomblin” under reviewers</li> </ul> No change on the Qualification data or material.

## 1. SCOPE:

This NMS converts NMS 397/1 (Form 3) slit tape form for Automated Fiber Placement (AFP) to NMS 397/3 (Form 3) for Automated Fiber Placement (AFP). This conversion takes place at the purchaser upon receipt of the shipment from material supplier.

Material supplier is responsible to perform batch release testing per NMS 397/1 and slit it to 0.25 inch slit tape at the approved slitter location per the PCD prior to shipping it to purchaser. Material supplier is not responsible to perform any testing listed in NMS 397/3 (Form 3).

Purchasers are to receive slitted form (0.25 inch) of NMS 397/1 from material supplier and responsible to convert material specification traceability from NMS 397/1 to NMS 397/3 upon receipt of the shipment and perform test receiving inspection per NMS 397/3. Purchasers are to specify “NMS 397/1 0.25 inch Slit Tape” in the purchase orders.

	Responsible Party	Task
Step 1	Purchaser	Create a purchase order (PO) to “NMS 397/1 Form 3 in 0.25 inch Slit Tape”.
Step 2	Material Supplier	Manufacture NMS 397/1 and perform batch release testing to NMS 397/1.
Step 3	Material Supplier	Ship NMS 397/1 material to approved slitter.
Step 4	Material Supplier’s Approved Slitter	Slit NMS 397/1 to 0.25 inch.
Step 5	Material Supplier’s Approved Slitter	Ship NMS 397/1 0.25 inch slit tape material to purchaser.
Step 6	Purchaser	Convert NMS 397/1 0.25 inch slit tape traceability to NMS 397/3 (Form 3).
Step 7	Purchaser	Perform receiving inspection per NMS 397/3 (Form 3).

*Purchasers are responsible to perform receiving inspection tests listed in this NMS.*

### 1.1 Form:

This detail specification along with the base specification NMS 397 establishes the requirements for continuous unidirectional carbon fiber impregnated with a modified B-staged epoxy resin (“unidirectional tape prepreg”). The prepreg is produced using a hot-melt process.

This detail specification follows the section and table numbering scheme of the base specification. It contains additional or superseding requirements. The base specification shall govern where no additional requirement is specified; in such cases, the applicable

sections are omitted from this detail specification.

- 1.3 Classification:** All products qualified to this detail specification have the following classification: Type 33.5, Class 1, Form 3 (0.25-inch Width), and Grade 192.

### 3. TECHNICAL REQUIREMENTS:

Table 1 – Slit Tape Physical and Chemical Properties (Class 1, Form 3)

Property	Test Method <sup>(1)</sup>	Number of Replicates	Requirements <sup>(2)(4)</sup>
Differential Scanning Calorimetry (DSC), T <sub>g</sub> <sup>(3)</sup>	ASTM E1356	Three samples of every batch	4.76 °C max, ind.

<sup>(1)</sup> Specific procedures should be identical to those used in the original material qualification program.

<sup>(2)</sup> “ind.” refers to individual measurements. “avg.” refers to the average measurements per roll.

<sup>(3)</sup> Limits computed using Qualification and historical production batches + shelf life and out-time data using 5 $\sigma$ .

<sup>(4)</sup> Product Form is Slit Tape Prepreg.

### 3.2 Constituent Material Requirements:

- 3.2.2 Reinforcement: Efforts to qualify the carbon fiber to NCAMP carbon fiber material specification, NMS 818, are ongoing. In the meantime, Toray will continue to provide aerospace-grade carbon fiber for this prepreg per the prepregger’s carbon fiber procurement specification and Toray’s internal aerospace-grade PCD. In addition, the following change control is implemented on the carbon fiber:

The carbon fiber tow product manufacturer shall establish control factors which will yield product meeting the technical requirements of this specification. The factors which are used in the production of fiber tow used in the prepreg material qualification shall constitute the approved factors; they shall be used for manufacturing production carbon fiber tow product. Control factors are Controlled Process Equipment and Controlled Process Parameters for producing the product. Control factors include, but are not limited to, the following:

- PAN Precursor formulation (raw ingredients and ratios),
- PAN Precursor manufacturing process, equipment, line, or site,
- PAN Precursor acceptance requirements,
- Carbon fiber tow processing parameters (e.g. temperature and speed),
- Carbon fiber tow manufacturing equipment, line, or site,
- Carbon fiber tow acceptance requirements,
- Carbon fiber tow acceptance test methods,
- Carbon fiber tow acceptance sampling plan,
- Carbon fiber tow surface treatment methods and levels,
- Carbon fiber tow sizing formulation and sizing level, and

k) Carbon fiber tow sizing application and drying methods, including equipment. If it is necessary to make any change in the above control factors, the carbon fiber tow product manufacturer shall submit for re-approval to NCAMP through the prepreg manufacturer in accordance with NRP 101 Prepreg Process Control Document (PCD) Preparation and Maintenance Guide. NRP 102 Polyacrylonitrile-based Carbon Fiber Process Control Document (PCD) Preparation and Maintenance Guide may be used as a reference. The change shall not be incorporated prior to the receipt of re-approval notice, typically in the form of a signed Advanced Change Notice (ACN).

### 3.4 Visual and Dimensional Requirements:

3.4.4 Roll characteristics - The standard width for Form 3 is 0.25 inches.

### 3.5 Laminate (Cured Prepreg) Requirements:

3.5.2 Cured Laminate Physical Properties:

TABLE 3 - Cured Laminate Physical Properties (Class 1, Form 3)<sup>(5)</sup>

Property	Test Method <sup>(1)</sup>	Requirements <sup>(2)</sup>
Cured Ply Thickness, CPT <sup>(3)</sup>	ASTM D3171 - Section 14.3.6	0.0066 to 0.0074 inch, avg.
Dry Glass Transition Temperature, Tg by DMA <sup>(4)</sup>	by flexural loading per ASTM D7028	355.3 to 391.3 °F, ind.

<sup>(1)</sup> Specific procedures should be identical to those used in the original material qualification program.

<sup>(2)</sup> "ind." refers to individual measurements. "avg." refers to the average measurements per panel.

<sup>(3)</sup> Cured Ply Thickness of the Laminates in Table 4. Computed from actual qualification panel thicknesses using  $\alpha=0.01$  and modified CV.

<sup>(4)</sup> Limits computed from average qualification data  $\pm 18^\circ\text{F}$ .

<sup>(5)</sup> Product Form is cured laminate using slit tape prepreg.

## 3.5.3 Cured Laminate Mechanical Properties:

TABLE 4 - Required Cured Laminate Tests for Mechanical Properties (Class 1, Form 3)<sup>(4)</sup>

Property	Test Method <sup>(1)</sup>	Requirements <sup>(3)</sup>
0° Tension Strength and Modulus Room Temperature, Ambient Layup: [0] <sub>6</sub>	ASTM D3039	Strength <sup>(2)</sup> : Min. Ind. $\geq$ 408.6 ksi Strength <sup>(2)</sup> : Average $\geq$ 483.4 ksi Modulus <sup>(2)</sup> : 22.55 to 26.79 msi, avg
90/0° Compression Strength and Modulus Room Temperature, Ambient Layup: [90/0/90] <sub>5</sub>	ASTM D6641	Strength <sup>(2)</sup> : Min. Ind. $\geq$ 81.7 ksi Strength <sup>(2)</sup> : Average $\geq$ 96.6 ksi Modulus <sup>(2)</sup> : 7.34 to 8.72 msi, avg
0° Short Beam Strength, Room Temperature, Ambient Layup: [0] <sub>14</sub>	ASTM D2344	Strength: Min. Ind. $\geq$ 13.7 ksi Strength: Average $\geq$ 15.7 ksi

<sup>(1)</sup> Specific procedures should be identical to those used in the original material qualification program.

<sup>(2)</sup> Normalize the properties to a cured ply thickness value of 0.0070 inch, based on actual qualification panel thicknesses, using the following equation:  

$$\text{Normalized\_Value} = \text{Measured\_Value} \times \text{Measured\_CPT} / \text{Nominal\_CPT}$$

<sup>(3)</sup> “ind.” refers to individual measurements. “avg.” refers to the average of 5 replicates. Limits computed at  $\alpha=0.01$  and modified CV.

<sup>(4)</sup> Product Form is cured laminate using slit tape prepreg.

## QUALIFIED PRODUCTS LIST

Supplier Product Designation	Supplier Name and Production Location	Date Qualified	Specification Callout <sup>(1)</sup>
Toray 3960 T1100GC-24K 0.25 inch Slit Tape P173EBN-19	Supplier Name: Toray Composite Materials America, Inc.  Production Location: 19002, 50 <sup>th</sup> Ave E. Tacoma, WA 98446	02/27/2024	NMS 397/3  Classification callout is optional because Type 33.5, Class 1, Form 3, Grade 192 is the only classification allowed in this QPL.

<sup>(1)</sup> In accordance with NCAMP Standard Operating Procedures, NSP 100, this QPL shall not contain alternate materials/products. Additional production location may be included in the QPL only after successful equivalency demonstration and approval per NCAMP Prepreg Process Control Document (PCD) Preparation and Maintenance Guide, NRP 101.

The proper specification callout for material conversion purpose is “NMS 397/3.” This specification is developed based on the material properties that are available publicly. The purchaser may specify additional requirements beyond those specified in this specification, especially when the purchaser has generated additional material properties beyond those available publicly or when the application requires additional requirements. The additional requirements are subject to supplier review and approval.