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NCAMP Material Specification

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

Medium Temperature, Out-of-Autoclave, Oven-Vacuum-Bag Cure Epoxy Resin
Impregnated Fiber Reinforced Composite Materials, Type 36, Class 2, Grade 193

Solvay (Formerly Cytec, Umeco Structural Materials (USM-OK), The Advanced
Composites Group (ACG)) MTM45-1 3K PW AS4 Fabric

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REVISIONS:

Rev	By	Date	Pages Revised or Added
N/C	Vinsensius Tanoto, Yeow Ng, John Tomblin	01/08/2019	Document Initial Release

1. SCOPE:

1.1 Form:

This detail specification along with the base material specification NMS 451 establishes the requirements for carbon fiber fabric impregnated with a modified B-staged epoxy resin ("fabric 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.

1.2 Classification: All products qualified to this detail specification have the following classification: Type 36, Class 2, Grade 193, Style 3k-AS4-GP-PW

2. TECHNICAL REQUIREMENTS:

Table 1 – Prepreg Physical and Chemical Properties

Property	Test Method ⁽¹⁾	Number of Replicates	Requirements ⁽³⁾
Resin Content	ASTM D3529	Every roll ⁽²⁾	36±3% ind. 36±2% avg.
Fiber Areal Weight	SACMA SRM 23R-94	Every roll ⁽²⁾	193±9 gsm ind. 193±8 gsm avg.
Volatile Content	ASTM D3530	First and last rolls of every batch ⁽²⁾	1% max ind. 0.7% max avg.
Flow	ASTM D3531	First and last rolls of every batch ⁽²⁾	21±5% avg.
Gel Time	ASTM D3532	Optional	58±12 minutes avg.
Tack	See 4.6.1	First and last rolls of every batch	Level IV
Drape	See 4.6.2	First and last rolls of every batch	Pass
HPLC	SACMA SRM 20R-94	One roll per batch ⁽⁴⁾	P1/P2 = 0.75 to 1.35 P1/P3 = 1.0 to 2.25 P1/P4 = 0.5 to 0.95
IR	ASTM E168 ASTM E1252	One roll per batch ⁽⁴⁾	A798/A1481 = 0.9 to 1.15
Differential Scanning Calorimetry (DSC) exotherm peak temperature	SACMA SRM 25R-94	Every resin batch	442.4 to 453.2 °F

- (1) Specific procedures should be identical to those used in the original material qualification program.
- (2) Three specimens should be taken across the width of the prepreg; left, center, right.
- (3) "ind." refers to individual measurements. "avg" refers to the average measurements per roll. Limits computed at $\alpha=0.01$ and modified CV.
- (4) Optional to perform either HPLC or IR.

2.1 Constituent Material Requirements:

- 2.1.1 Reinforcement: Efforts to qualify the carbon fiber to NCAMP carbon fiber material specification, NMS 818, are ongoing. In the meantime, Solvay will continue to provide aerospace-grade carbon fiber for this prepreg per the prepregger's carbon fiber procurement specification - CF0525 and aerospace grade AS4 fabric per HS-CP-5000. 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:

- a) PAN Precursor formulation (raw ingredients and ratios),
- b) PAN Precursor manufacturing process, equipment, line, or site,
- c) PAN Precursor acceptance requirements,
- d) Carbon fiber tow processing parameters (e.g. temperature and speed),
- e) Carbon fiber tow manufacturing equipment, line, or site,
- f) Carbon fiber tow acceptance requirements,
- g) Carbon fiber tow acceptance test methods,
- h) Carbon fiber tow acceptance sampling plan,
- i) Carbon fiber tow surface treatment methods and levels,
- j) 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).

2.2 Visual and Dimensional Requirements:

- 2.2.1 Roll characteristics - The standard width for this product is 50 inches. Other widths may be supplied only if it is specifically requested by the purchaser.

2.3 Laminate (Cured Prepreg) Requirements:

2.3.1 Cured Laminate Physical Properties:

TABLE 3 - Cured Laminate Physical Properties

Property	Test Method ⁽¹⁾	Requirements ⁽²⁾
Cured Ply Thickness ⁽³⁾	SACMA SRM 10R-94	Between 0.00756 and 0.00838 inch, avg.
Dry Glass Transition Temperature, Tg by DMA ⁽⁴⁾	SACMA SRM 18R-94	Between 358.31 and 391.92 °F, ind.

- (1) Specific procedures should be identical to those used in the original material qualification program.
- (2) "ind." refers to individual measurements. "avg" refers to the average measurements per panel.
- (3) Computed from actual qualification panel thicknesses. Limits computed at α=0.01 and modified CV.
- (4) Computed from additional data because the qualification data was found to be incorrectly tested. Limits computed at α=0.01.

2.3.2 Cured Laminate Mechanical Properties:

TABLE 4 - Required Cured Laminate Tests for Mechanical Properties (Class 2)

Property	Test Method ⁽¹⁾	Requirements ⁽³⁾
0° (warp) Tension Strength and Modulus, Room Temperature Dry Layup: [0] ₁₄	ASTM D3039	Strength ⁽²⁾ : Min. Ind. ≥ 106.8 ksi Strength ⁽²⁾ : Average ≥ 122.9 ksi Modulus ⁽²⁾ : Between 8.5 and 10.1 msi avg.
90° (fill) Compression Strength and Modulus, Room Temperature Dry Layup: [90] ₁₈	ASTM D6641	Strength ⁽²⁾ : Min. Ind. ≥ 60.64 ksi Strength ⁽²⁾ : Average ≥ 77.52 ksi Modulus ⁽²⁾ : Between 7.3 and 8.8 msi avg.
90° (fill) Short Beam Strength, Room Temperature Dry Layup: [90] ₁₈	ASTM D2344	Strength: Min. Ind. ≥ 8.49 ksi Strength: Average ≥ 9.70 ksi

- (1) Specific procedures should be identical to those used in the original material qualification program.
- (2) Normalize the properties to a nominal cured ply thickness (CPT) value of 0.0079 inch based on theoretical nominal CPT, using the following equation:
Normalized_Value = Measured_Value x Measured_CPT / Nominal_CPT.
- (3) "ind." refers to individual measurements. "avg" refers to the average of 5 replicates. Limits computed at α=0.01 and modified CV.

QUALIFIED PRODUCTS LIST

Supplier Product Designation	Supplier Name and Production Location	Date Qualified	Specification Callout ⁽¹⁾
MTM45-1/CF0525-36%RW	Supplier Name: Solvay (Formerly Cytec, Umeco Structural Materials (USM-OK), The Advanced Composites Group (ACG)) Production Location: 5350 South 129 th East Avenue, Tulsa, OK 74134 USA	March 08, 2010	NMS 451/7 Classification callout is optional because Type 36, Class 2, Grade 193 is the only classification allowed in this QPL.

⁽¹⁾ 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.

⁽¹⁾ The proper specification callout for material procurement purpose is “NMS 451/7.” This specification was 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.