



Epoxy/Epoxide Woven Fabric - Reinforced Composite Materials

1 Scope

1.1 Material Description. This specification covers the properties of epoxy/epoxide resin reinforced woven fabric composites fabricated using carbon fiber fabric preforms, such as weaves, braids, stitched preforms and so forth as the reinforcement.

1.1.1 Adhesive Bonding. The intended production bonding system (substrate and adhesive) shall meet the requirements of GMW15921 when tested in the laboratory. Production representative parts, and/or assemblies, shall meet the requirements of GMW16185 when tested according to the specification.

1.1.2 Paint. As follows:

- For painted applications, the material must meet the requirements of GMW16172
- For body or accent color applications, low bake topcoat per 9984901, 9984904 should be used
- For exposed weave applications, apply clear coat per GMW15703

1.2 Symbols. Not applicable.

1.3 Applicability. A-surface of exposed weave carbon fiber components (fenders, hoods, roofs, etc.) Typical applications include the following:

- Type I: Standard carbon fiber fabric reinforced epoxy/epoxide composites with no V-0 requirement
- Type II: V-0 woven carbon fiber reinforced epoxy/epoxide for engine cover applications

1.4 Remarks. All materials are Type I unless otherwise specified. The woven fabric can be used as a decorative single ply on top of a unidirectional stack-up, or as a multi-layer stack-up.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM D792	ASTM D3410/3410M	ASTM D5229	ASTM E228
ASTM D2734	ASTM D3518/3518M	ASTM D5379/5379M	ISO 11359-2
ASTM D3039/3039M	ASTM D4065	ASTM D6641/6641M	UL 94
ASTM D3171	ASTM D4255/4255M	ASTM D6856	

2.2 GM Standards/Specifications.

9984901	GMW3221	GMW14444	GMW16172
9984904	GMW3232	GMW15703	GMW16185
GMW3059	GMW14270	GMW15921	GMW16853

2.3 Additional References. None.

3 Requirements

3.1 Requirements on Test Specimens. Reference GMW3221, Code A.

3.2 Emissions Testing of Interior Materials and Parts. For all Code E designated parts per GMW14444, reference GMW16853 for emissions testing of interior materials and parts.

3.3 Sampling. Testing should be carried out with laminates molded from three (3) distinct lots (batches) of materials. A lot (batch) is defined as a quantity of material produced at the same time and under the same

conditions from a well-defined collection of raw materials. The quantity of material must have minimal variation in properties throughout to be considered a unique lot (batch). For the laminate, a lot (batch) is defined as one (1) lot (batch) of fabric and one (1) lot (batch) of resin(s). Material suppliers must certify molding compound properties to the specific GM Test Sampling Plan approved for that material.

3.4 Baseline Cure Process. It is recommended that the material supplier establish a baseline cure cycle to be used to produce a laminate for the batch acceptance testing. The baseline cure cycle should be selected based on the end user applications and requirements for the material. Reasonable tolerances on heat-up rates and time at temperature should be established and documented. The cure process shall be capable of producing cured laminates of consistent, high quality. The following process conditions should be documented for each material used:

- Preform thickness
- Preform binder
- Molding technique
- Molding temperatures and molding pressure
- Molding time and panel dimensions

The amount of debulking of the preform needs to be documented. Refer to Table 1 for laminate thickness and panel requirements.

Table 1: Laminate Thickness and Panel Requirements - Woven Materials

Layup	Test	Number of Batches X, Number of Panels X, Number of Tests/Batch/Panels		
		Test Temperature/Moisture Condition		
		-40 °C Ambient	23 °C Ambient	85 °C Ambient
(0)n ^{Note 1}	Tensile ASTM D3039	-	3X2X3	1X2X3
(0)n ^{Note 1}	Compression ASTM D6641 or ASTM D3410	-	3X2X3	1X2X3
(+45/-45) _{n_s} ^{Note 2}	In plane Shear ASTM D5379 or ASTM D4255 or ASTM D3518	3X2X3	3X2X3	3X2X3

Note 1: Select a value of *n* such that the laminate thickness is approximately 2.54 mm (0.100 in).

Note 2: Select a value of *n* such that $2 \leq n \leq 4$ (*N_s* = symmetrical).

3.5 Specimen Geometry. Textile composites have a repeating geometrical pattern. This repeating pattern is referred to as the unit cell. Unit cell is defined as the smallest section of the textile architecture required to replicate the textile pattern by using only in-plane translation (and no rotations) of the unit cell. Refer to ASTM D6856 for further definition. The recommended ratio of specimen width to unit cell width for a textile composite is 2:1. The larger of, (1) the specimen width dictated by this recommended ratio and, (2) the specimen width recommended in the corresponding ASTM standard for the measured property should be used to ensure that at least two (2) unit cells are included within the specimen gage section.

3.6 Test Procedures. Tests shall be conducted using the latest issue of the test methods indicated. Suitable precautions should be taken to ensure that applicable safe limits are not exceeded when conducting test procedures, processes and/or handling the materials required by this specification.

3.6.1 Resin/Fiber Content of Laminate. Use ASTM D3171, Method 1, Procedure A or Method 2 for constituent composite materials. If using Method 2 for resin/fiber content, use ASTM D2734, Method A for void content. Report the fiber, resin and void content by percent volume.