



Polyamide 6 - Carbon Fiber Reinforced, Heat Stabilized, Weatherable, Compression Moldable

1 Scope

1.1 Material Description. This specification describes chopped carbon fiber reinforced, heat stabilized, weatherable polyamide 6 (nylon 6) which is used in compression moldable components.

1.2 Symbols. The material abbreviations according to ISO 11469 are shown in Table 1.

1.3 Applicability. Typical applications include the following: composite structural parts.

1.4 Remarks. The classification into groups is according to the different ranges of carbon fiber content. Additional carbon ranges will be added as they become necessary.

2 References

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

2.1 External Standards/Specifications.

ASTM D3410	ISO 306	ISO 4892-1/2	ISO 15512
ASTM D6869	ISO 527-4	ISO 6603-1/2	JIS K7164
ASTM E831	ISO 1183	ISO 11357-3	SAE J1545
ISO 179/1eU	ISO 2577	ISO 11359-2	SAE J1976
ISO 188	ISO 3146	ISO 11469	SAE J2527

2.2 GM Standards/Specifications.

GMW3013	GMW3221	GMW3059	GMW14335
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2.3 Additional References.

TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

3 Requirements

Materials approved to this specification shall meet the requirements of GMW3013, **General Requirements for Handling of Technical Terms of Delivery for Plastics.**

3.1 Requirements on Test Specimens. Reference GMW3221. Unless otherwise specified, all specimens for testing shall be obtained from molded plaques with a thickness of 2.5 mm $\pm$ 0.5 mm. The specimens shall be molded using temperatures and pressures typical of those used in production. Tensile test bars shall conform to the requirements of JIS K7164.

All values indicated herein are based on material considered to be in the dry-as-molded state with moisture content of 0.2% maximum (ASTM D6869, ISO 15512 Method A or B, or GMW14335). The test specimens shall be dried at 120 °C for 48 h and shall be sealed in moisture proof containers.

In addition, tests specified at temperatures below or above 23 °C $\pm$ 2 °C shall be conducted at the specified temperature using specimens conditioned at the specified temperature for 4 h minimum.

The values specified in Table 1 shall be met by test specimens in natural, black or in a standard sampled color if natural or black are not available. The values specified in Table 2 shall be met by a typical exterior color for approval to the specification and/or test specimens in specific colors as required during color development.

3.2 Requirements on Delivery. Important physical, mechanical and thermal properties that characterize the material are summarized in Tables 1 and 2. The color shall be specified on drawings, in material specifications and otherwise.

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3.3 Compound Properties. See Tables 1 and 2. The following are also required for full standard approval. The minimum number of lots per test required for the following properties is one in natural: Poisson's Ratio, Coefficient of Linear Thermal Expansion (CLTE), Mold Shrinkage, Stress Strain Curve at multiple temperatures (for example -30 °C, 23 °C, 85 °C). Deviations from GMW 3013 test procedures and parameters listed in Tables 1 and 2 take precedence. See GMW3013 for all test procedures and parameters.

3.4 Performance Requirements. Performance requirements shall be specified on part drawings or in component specifications. All parts manufactured from molding components shall be resistant to the media they contact, such as aliphatic and aromatic hydrocarbons, fuels, lubricants, oils, greases and alcohols, at their places of use.

Table 1: Compound Properties (Natural and Black)

Property ^{Note 1}	Standard	Unit	Nominal Carbon Fiber Content	
			35%	Value
ISO Symbol	ISO 11469	-	>PA6-CF35<	
Carbon Fiber Content	ISO 1183	% by volume	32 to 38	
Density	ISO 1183	g/cm ³	Target Range 1.32 to 1.40	
Moisture Content	ISO 15512, Method B	%	≤ 0.2	
Tensile Modulus	ISO 527-4, test speed 2 mm/minute, between 0.05 and 0.25% strain	GPa	24 to 29	
Tensile Stress at Break	ISO 527-4, test speed 2 mm/minute	MPa	≥ 317	
Tensile Stress at Break after Heat Aging, 1000 h at 160 °C	ISO 527-4 ISO 188	% Retention	≥ 75	
Tensile Strain at Break	ISO 527-4	%	≥ 1.3	
Compressive Modulus	ASTM D3410 at 23 °C	GPa	22 to 30	
Compressive Stress at Break	ASTM D3410 at 23 °C	MPa	≥ 208	
Unnotched Charpy Impact Strength at +23 °C (flatwise)	ISO 179/1eU	kJ/m ²	≥ 73	
Unnotched Charpy Impact Strength after Heat Aging, 1000 h at 160 °C (flatwise)	ISO 179/1eU ISO 188	% Retention	≥ 75	
Multiaxial Impact at 23 °C	ISO 6603-1/2	J	≥ 39	
Melting Temperature	ISO 3146 or ISO 11357-3	°C	Target Range 218 to 221	
Vicat Softening Temperature	ISO 306	°C	≥ 218	
CLTE (Coefficient of Linear Thermal Expansion) Parallel to Flow Perpendicular to Flow	ASTM E831 or ISO 11359-2, Thermal Mechanical Analysis (TMA) Mean secant value over the temperature range -30 °C to +30 °C	10 ⁻⁶ mm/mm/°C	≤ 14 ≤ 16	
Mold Shrinkage (for reference only) after 48 h at 23 °C Parallel to Flow Perpendicular to Flow	ISO 2577	%	Target Range -0.1 to -0.07 -0.1 to -0.06	

Note 1: These values shall be determined in dry as molded condition. The mechanical properties of types conditioned to equilibrium at room temperature and 50% relative humidity have significantly altered values.

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