GM	WORLDWIDE ENGINEERING STANDARDS	Material Specification	GMW3029

Polyamide 6 - Glass Fiber Reinforced, Heat Stabilized

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose/Material Description. This specification describes material types of glass fiber reinforced, heat stabilized Polyamide 6 (nylon 6), which are used in injected or extruded form for molded components.

1.2 Symbols. The symbol, per ISO 11469, shall be completed by the supplier according to the glass fiber content of the material. The material abbreviations according to ISO 11469 are shown in Table 1 and Table 2.

1.3 Applicability. Painted Wheel Covers, Pedals, Gears, Spacers, Relays, Brackets, Fans.

1.4 Remarks. Not applicable.

2 References

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

2.1 External Standards/Specifications.

ISO 75-2	ISO 527-1/2	ISO 3451-1	ISO 11469
ISO 179-1/1eA	ISO 1183-1	ISO 3451-4	ISO 15512
ISO 188	ISO 1183-2	ISO 3795	ISO 16396-2
ISO 294-1	ISO 3146	ISO 11357-3	

2.2 GM Standards/Specifications.

GMW3013	GMW3232	GMW14444	GMW16853
GMW3059	GMW3235	GMW14797	
GMW3205	GMW14270	GMW15634	
GMW3221	GMW14335	GMW16172	

2.3 Additional References.

- Plastic Submission Template

3 Requirements

3.1 Requirements on Test Specimens. Materials approved to this specification shall meet the requirements of GMW3013.

Unless otherwise specified, injection molding of test specimens shall be accomplished per ISO 294-1 with the conditions for injection molding from ISO 16396-2. Test methods and specimen dimensions are also to be in accordance with ISO 16396-2.

All values indicated herein are based on material considered to be in the dry-as-molded state with moisture content of 0.2% maximum (ISO 15512 Method A or Method B, or GMW14335). Immediately after molding, per ISO 16396-2, specimens shall be sealed in moisture-proof containers and stored at 23 °C ± 2 °C for at least 24 h. All tests shall be performed on unannealed specimens immediately after their removal from the containers in a controlled atmosphere per GMW3221, Code A, unless otherwise specified. In addition, tests specified at temperatures below or above 23 °C ± 2 °C shall be conducted at the specified temperature using specimens conditioned at the specified temperature for 4 h minimum.

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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. See the Polyamide tab on the Plastics Submission Template and GMW3013 for test details and parameters.

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

3.3 Compound Properties (Natural and Black). The following are also required for full approval. The minimum number of lots per test required is one unless otherwise specified. See the Polyamide tab on the Plastics Submission Template and GMW3013 for test details and parameters.

- Poisson's Ratio
- Stress/strain data points and curves at the following temperatures:

  -30 °C, +23 °C, +85 °C, +110 °C, +125 °C, +150 °C.

  Note: See GM Material Property Database (GMMPD) tab on Plastics Submission Template for test details (contact specification owning group named in Section 6 for access).
- Coefficient of Linear Thermal Expansion (CLTE) data.

  Note: See GMMPD tab on Plastics Submission Template for test details (contact specification owning group named in Section 6 for access).
- Differential Scanning Calorimetry (DSC) curve.
- Fourier Transform Infrared (FTIR) spectroscopy curve.
- Mold shrinkage.

3.4 Initial Source Approval. No shipments shall be made by any supplier until representative initial production samples have been approved by the appropriate Materials Engineering department(s) as meeting the requirements of this specification.

3.5 Requirements on Parts. Parts of this material type shall have a water content at delivery, when tested per GMW14335 or ISO 15512, Method A or Method B, of at least:

- 1.5% by mass for material types reinforced up to 20% by mass.
- 1.0% by mass for material types reinforced over 20% by mass.

Deviations from this shall be specifically indicated on the part drawings.

3.6 Performance Requirements. Performance requirements shall be specified on part drawings or in component specifications. All parts manufactured from these materials shall be resistant to the media contacted at the place of use, such as aliphatic and aromatic hydrocarbons, fuels, lubricants, oils, greases and alcohols.

3.7 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.

3.8 Paintability. Plastics used for painted applications are required to meet Paint Performance Requirements for New Plastic Materials per GMW16172. Additionally, painted plastic parts are required to meet Painted Plastic Parts Performance Requirements per GMW14797.

3.9 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to obtain a GM-approved International Material Data System (IMDS) submission.

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Table 1: Compound Properties (Natural and Black)
Glass Fiber Reinforcement, 5% through 30%

			Nominal Glass Fiber Reinforcement Percentage				
Property Note 1	**Standard**	**Unit**	**5%**	**15%**	**20%**	**25%**	**30%**
			Range	**Range**	**Range**	**Range**	**Range**
International Organization for Standardization (ISO) Symbol	ISO 11469	-	>PA6-GF5<	>PA6-GF15<	>PA6-GF20<	>PA6-GF25<	>PA6-GF30<
Ash	ISO 3451-1 ISO 3451-4	%	4 to 7	13 to 17	18 to 22	22 to 28	27 to 33
Density	ISO 1183-1 ISO 1183-2	g/cm^3	Target Range 1.13 to 1.20	Target Range 1.20 to 1.26	Target Range 1.22 to 1.28	Target Range 1.28 to 1.34	Target Range 1.33 to 1.39
Moisture Content	ISO 15512 Method A or B, or GMW14335	%	≤ 0.2				
Tensile Modulus	ISO 527-1/2	MPa	Report data	5000 to 6500	5750 to 7250	7250 to 8750	8500 to 10 900
Tensile Stress at Break	ISO 527-1/2	MPa	≥ 95	≥ 110	≥ 125	≥ 149	≥ 155
Tensile Elongation at Break	ISO 527-1/2	%	Report data	≥ 2.5	≥ 2.0	≥ 2.0	≥ 2.0
Tensile Stress at Break after Heat Aging Note 2	ISO 188 ISO 527-1/2 1000 h at +140 °C	% Retention	≥ 80		≥ 90		
Notched Charpy Impact Strength at +23 °C at -30 °C	ISO 179-1/1eA	kJ/m^2	Report data	≥ 4 ≥ 3	≥ 4 ≥ 3	≥ 5 ≥ 4	≥ 6 ≥ 5
Notched Charpy Impact Strength after Heat Aging Note 2	ISO 188 ISO 179-1/1eA 1000 h at +140 °C	% Retention	≥ 80		≥ 85		
Melting Temperature	ISO 3146 or ISO 11357-3	°C	Target Range 211 to 225	Target Range 211 to 225	Target Range 211 to 225	Target Range 211 to 225	Target Range 211 to 225
Heat Deflection Temperature under Load, 1.8 MPa	ISO 75-2	°C	≥ 120	≥ 185	≥ 190	≥ 198	≥ 197

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