



Polyphthalamide – Glass Fiber Reinforced, Transmission Fluid Resistant, Heat Stabilized, Hot Oil Moldable

1 Scope

1.1 Material Description. This standard covers properties of various types of glass fiber reinforced, transmission fluid resistant, heat stabilized polyphthalamide (PPA), injection moldable, hot oil moldable.

1.2 Symbols. The material abbreviations according to SAE J1344 are shown in Table 1.

1.3 Applicability. Typical applications: charged air cooler ducts, various transmission and electrified drive unit components.

1.4 Remarks. The classification into groups is according to the different ranges of glass fiber content. The Cross Reference and Replaced Specifications table lists replaced specifications.

2 References

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

2.1 External Standards/Specifications.

ASTM D6869	ISO 294	ISO 1874-2	ISO 11357-3
ISO 75	ISO 527	ISO 3146	ISO 15512
ISO 179	ISO 527-2	ISO 3451	ISO 22088-3
ISO 179/1eA	ISO 1183	ISO 3795	SAE J1344
ISO 188	ISO 1874-1	ISO 6721	

2.2 GM Standards/Specifications.

GMW3013	GMW3232	GMW14335	GMW16444
GMW3059	GMW14270	GMW14444	GMW16853
GMW3221			

3 Requirements

3.1 Requirements on Test Specimens. Reference GMW3221.

3.1.1 Unless otherwise specified, injection molding of test specimens shall be accomplished per ISO 294, with the conditions for injection molding from ISO 1874-1.

3.1.2 All values indicated herein are based on material considered to be in the dry-as-molded state, with moisture content of 0.2% maximum (ASTM D6869, ISO 15512 Method A or B, or GMW14335). Immediately after molding, specimens shall be sealed in moisture-proof containers and stored at $+23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ for at least 24 h prior to test, as specified in ISO 1874-2. All tests shall be performed on unannealed specimens immediately after their removal from the containers into a controlled atmosphere, per GMW3221, Code A (unless otherwise specified.) In addition, tests specified at temperatures below or above $+23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ shall be conducted at the specified temperature using specimens conditioned at the specified temperature for 4 h minimum.

3.1.3 The minimum values specified in Table 1 must be met by test specimens in natural or black color. A standard sample color can be used if natural or black are unavailable.

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

3.4 Compound Properties (Natural and Black). See Table 1. The following are also required for full standard approval. The minimum number of lots per test required is one (1) in natural: Poisson's Ratio, electronic Stress/Strain Curve at multiple temperatures (for example -30 °C, +23 °C, +125 °C, +170 °C), Coefficient of Linear Thermal Expansion (CLTE), Mold Shrinkage, Dynamic Mechanical Analysis (DMA), -40 °C to +200 °C, ISO 6721, +5 °C/minute, 1 Hz. See GMW3013 for all test procedures and parameters.

3.5 Performance Requirements. Performance requirements shall be specified on part drawings or in component specifications.

3.6 Requirements for Transmission Fluid Resistance. The tensile and impact properties of the material in this standard shall meet transmission fluid resistance requirements specified in Table 1. Test fluid shall be Dexron® VI in accordance with GMW16444.

Test requirements are as follows: Samples shall be aged in suitable vented vessels. Minimum fluid to sample ratio shall be 150 mL to three (3) specimens. A minimum of five (5) specimens shall be tested per condition for the tensile stress, tensile elongation and impact after transmission fluid exposure. A minimum of three (3) specimens shall be tested for the Environmental Stress Crack Resistance (ESCR) tests. Samples shall have insignificant contact with the vessel. For tensile tests, contact is allowed outside length L specified in ISO 527-2. Alterations shall not be made inside the length L specified in ISO 527-2 to suspend specimens. For proof tests at room temperature, samples shall be brought to room temperature in the aging fluid, or in fresh transmission fluid (for room temperature testing). Samples may be tested within 30 minutes without conditioning. After 30 minutes, samples must be stored in a conditioned environment (+23 °C ± 5 °C and 50% Relative Humidity (RH) ± 5% RH) for up to 14 days. Samples shall then be wiped with filter paper or a lint free cloth before testing.

Tensile stress at break and elongation at break for environmental stress cracking resistance shall be determined using ISO 527 with Type 1 specimens.

Table 1: Compound Properties (Natural and Black)

			Nominal Glass Fiber Reinforcement Percentage				
			15%	35%	40%	45%	50%
Property	Standard	Units	Range	Range	Range	Range	Range
SAE Symbol	SAE J1344		>PPA-GF15 <	>PPA-GF35 <	>PPA-GF40<	> PPA-GF45 <	>PPA-GF50<
Ash	ISO 3451	%	13 to 17	32 to 38	37 to 43	42 to 48	47 to 53
Density	ISO 1183	g/cm ³	Target Range 1.27 to 1.33	Target Range 1.40 to 1.50	Target Range 1.52 to 1.58	Target Range 1.55 to 1.62	Target Range 1.62 to 1.69
Tensile Modulus	ISO 527	MPa	6000 to 8000	9500 to 14 500	14600 to 16700	13 000 to 19 000	17500 to 21500
Tensile Stress at Break	ISO 527	MPa	≥ 95	≥ 180	≥ 220	≥ 215	≥ 240
Stress at Break after Heat Aging Note 1	ISO 188 ISO 527 1000 h at +170 °C	% Retention	≥ 75				
Moisture Content	ISO 15512 Method A or B or GMW14335	%	≤ 0.2				
Notched Charpy Impact Strength: at +23 °C at -30 °C	ISO 179/1eA	kJ/m ²	≥ 2.4 ≥ 2.4	≥ 8 ≥ 7.5	≥ 9.7 ≥ 9.5	≥ 7.5 ≥ 7.5	≥ 10 ≥ 7.5