



Polyimide – 15% Graphite Powder Filled

1 Scope

1.1 Material Description. This specification applies to a 15% graphite powder filled polyimide. The material has a decomposition temperature that is in excess of +400 °C and shows no glass transition temperature or melting point.

1.2 Symbols. The material abbreviation according to ISO 11469 and ISO 1043 is >PI-GRAPHITE15<.

1.3 Applicability. Typical applications include the following: Transmission rotating seal rings, thrust washers or other wear and sealing applications where high load (high pressure-velocity (PV)) resistance, high temperature resistance, low wear/low friction are required.

2 References

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

2.1 External Standards/Specifications.

ASTM C117	ASTM D6456	ISO 527	ISO 6721
ASTM D638	ASTM E831	ISO 604	ISO 11359-2
ASTM D792	ISO 175	ISO 1043	ISO 11469
ASTM D3702	ISO 179/1eA	ISO 1183	

2.2 GM Standards/Specifications.

9986153	GMW3059	GMW14270	GMW17081
GMW3013	GMW3221	GMW16771	

3 Requirements

3.1 Requirements on Test Specimens. Test specimens shall be prepared by direct forming and sintering process similar to those used to make production parts.

Note: Certain processing conditions are used to control final part characteristics and, therefore, vary within allowable ranges from those conditions used to produce test specimens.

Surfaces shall be free of external mold release agent. (Mold and scrap a minimum of three (3) plaques after using external mold release agent.)

If test specimens are to be machined from molded plaques, an equal number of specimens shall be cut from both the longitudinal and transverse plaque directions.

Tests shall be conducted at least 40 h after sintering. In addition, test specimens shall be conditioned to GMW3221, Code A prior to testing unless otherwise specified.

3.2 Material Requirements. Requirements on mechanical, physical, and thermal properties of the material are summarized in Table 1.

The following are also required for full standard approval. The minimum number of lots per test required is one in natural: Thermal conductivity, wear characters and PV limit, fluid resistance to GM specified ATF, and Infrared spectrum and differential scanning calorimeter curve from -40 °C to +350 °C of the material. See GMW3013 and the relevant template for all test procedures and parameters.

In addition, the moduli as a function of temperature (dynamic mechanical property) of the material at 1 Hz shall be reported in accordance to ISO 6721 for temperature range from -50 °C to +280 °C at +5 °C intervals.

The material shall meet ASTM D6456, Type II Class 1D requirements at batch releases.

3.3 Material Properties for FEA. Tensile properties of the material shall be measured in accordance to ISO 527 at -40 °C, +23 °C, and +150 °C. Tests shall be performed using ISO 527-1BA specimen, five (5) duplicates each, at 5 mm/minute. ASTM D638 toe compensation shall be applied to data. Submit stress-strain data in accordance to GMW3013/GMMPD format. Report tensile modulus and stress/strain at break.

Coefficient of linear thermal expansion (CLTE) shall be measured in accordance to ISO 11359-2 for both flow and cross flow directions from -45 °C to +260 °C. Report sample length vs. temperature in accordance to GMW3013/GMMPD requirements.

Report Poisson's ratio at +23 °C in accordance to ISO 527.

3.4 Requirements on Parts. The finished parts shall meet requirements as specified per GMW17081 Z=Density, 1.41 g/cm³ minimum.

Table 1: Material Properties

Property	Test Method	Unit	Value
Density	ISO 1183/ASTM D792	g/cm ³	1.42 to 1.48
Graphite Filler	ASTM D6456	% by mass	14 to 16
Tensile Modulus at +23 °C at +260 °C	ISO 527, Type 1BA, 1 mm/minute	MPa	≥ 2380 to 3660 ≥ 1500
Tensile Strength at Break at +23 °C at +260 °C	ISO 527, Type 1BA, 2 mm/minute	MPa	≥ 52 ≥ 30
Elongation at Break at +23 °C at +260 °C	ISO 527, Type 1BA, 2 mm/minute	%	≥ 3.4 ≥ 2.7
Notched Charpy Impact Strength at +23 °C	ISO 179/1eA, edgewise impact	kJ/m ²	≥ 1.9
Notched Charpy Impact Strength at -40 °C	ISO 179/1eA, edgewise impact	kJ/m ²	≥ 1.7
Compressive Strength	ISO 604	MPa	≥ 195
Properties After Fluid Aging Tensile Strength Elongation at Break Notched Charpy Impact Strength	ISO 175, Immersion in DEXRON VI® ATF (9986153), 1000 h at +150 °C, followed by the indicated property testing at +23 °C. Test methods are the same as for original mechanical property testing.	% Retention	≥ 90 ≥ 60 ≥ 65
Thermal Conductivity	ASTM C117	W/m·K	0.50 to 0.55
Coefficient of Thermal Expansion Perpendicular to Pressing Parallel to Pressing	ASTM E831 (TMA) -45 °C to +260 °C	10 ⁻⁶ mm/mm/°C	≤ 50 ≤ 68
Wear Rate	Modified ASTM D3702, 1.29 MPa, 0.68 m/s, (0.878 MPa·m/s) 24 h	m/h	≤ 2.8 × 10 ⁻⁵
PV (pressure-velocity) Limit Sequence A Sequence B	GMW16771 Wear Testing Procedure for Plastic Materials against Metal Mating Surfaces under Dry Condition, report PV limit and coefficient of friction	MPa·m/s	≥ 17.51 (500,000) ≥ 15.76 (450,000)

Note: ATF = Automatic Transmission Fluid, PV = Pressure-Velocity, TMA = Thermomechanical Analysis