



Reinforced Polyamide 66 or Polyamide Alloys for High Voltage Insulation

1 Scope

1.1 Material Description. This standard specifies the requirements for reinforced polyamide 66 (Nylon 66) resins and any alloys of polyamide for high voltage insulation purposes. Materials approved to this specification cannot have a halogenated heat stabilizer package.

1.2 Symbols. The material abbreviations in accordance with ISO 1043-1 and ISO 11469 are shown in Table 1.

1.3 Applicability. 125 °C rated high voltage (60 VDC to 600 VDC) insulation, both Alternating Current (AC) and Direct Current (DC).

1.4 Remarks. Materials are classified according to reinforcement type and content. Materials may also be classified as flame resistant.

2 References

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

2.1 External Standards/Specifications.

ASTM E831	ISO 179-1	ISO 3146	ISO 11359-2
ASTM E1252	ISO 188	ISO 3451-4	ISO 11469
IEC 60112	ISO 294-1	ISO 6721	ISO 15512
IEC 60243-1	ISO 527-1	ISO 6721-11	ISO 16396-2
IEC 60695-11-10	ISO 527-2	ISO 11357-1	UL 94
IEC 62631-3-1	ISO 1043-1	ISO 11357-3	
ISO 75-1	ISO 1183	ISO 11358	

2.2 GM Standards/Specifications.

GMW3013	GMW3221	GMW18109
GMW3059	GMW14270	

3 Requirements

Material shall meet all requirements stated herein when tested and reported in accordance to GMW3013 and the designated GMW Plastic Submission Template.

3.1 Requirements on Test Specimens.

Unless otherwise specified, test specimens shall be injection molded in accordance to ISO 294-1 and ISO 16396-2. Specimen dimensions shall meet respective test requirements.

All values indicated herein are based on materials considered to be in the dry-as-molded state with moisture content of 0.2% maximum (ISO 15512 Method A or Method B). Immediately after molding, specimens shall be sealed in moisture-proof containers and stored at 23 ± 2 °C for at least 24 h prior to test as specified in ISO 16396-2.

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.

Tests specified at temperatures $< 23 \text{ °C} \pm 2 \text{ °C}$ shall be conducted at the specified temperature using specimens conditioned at the specified temperature for 4 h minimum. Test specimens shall be conditioned at specified temperatures for 60 minutes $+60/-0$ minutes for tests at temperatures $> 23 \text{ °C} \pm 2 \text{ °C}$.

3.2 Requirements on Physical and Mechanical Properties. See Table 1 for general requirements. Refer to GMW3013 and the accompanied template for test methods and report details.

3.3 Requirements on Electrical Insulation Properties. The material shall demonstrate volumetric resistivity and dielectric strength at room temperature and 125 °C as specified in Table 1 when tested to GMW18109 and IEC 60243-1, respectively, with mutually agreed sample and electrode arrangements.

The material shall demonstrate comparative tracking index specified in Table 1 in accordance to IEC 60112.

3.4 Requirements on Flame Resistance. For specifications with Code F designation, the material shall meet V-0 rating in accordance to IEC 60695-11-10/UL 94 at 0.75 mm thickness.

3.5 Requirements on Material Properties after Heat Aging. The material shall demonstrate mechanical properties as well as electrical insulation properties specified in Table 1 after heat aging at 125 °C for 1000 h in accordance to ISO 188.

3.6 Requirements on Dynamic Mechanical Properties and Glass Transition. Dynamic mechanical properties of the material shall be measured as a function of temperature from -40 °C to 200 °C at 1 Hz frequency 2 °C/minute in air in accordance to ISO 6721, non-resonance test method. Strain level should be in the linear response range. Report storage modulus, loss modulus, and loss tangent as functions of temperature. Report T_g , T_{onset} , T_{endset} based on ISO 6721-11.

3.7 Requirements on Material Finite Element Analysis (FEA) Properties.

- Poisson's Ratio at 23 ± 2 °C.
- Stress-Strain properties at temperatures of -40 °C, 23 °C, 80 °C/85 °C, 125 °C/130 °C, and 150 °C shall be provided in accordance with the Plastic Submission Template GM Material Property Database (GMMPD) template instructions.
- Linear Thermal Expansion between -40 °C to 160 °C. Thermal expansion shall be measured from -40 °C to 160 °C for both flow direction and cross flow directions according to ASTM E831 or ISO 11359-2 and reported in accordance with the Plastic Submission Template GMMPD template instructions. Secant Coefficients of Linear Thermal Expansion (CLTE) shall also be reported for temperatures both below and above glass transition temperature as specified in Table 1.

3.8 Additional Requirements.

- Fourier-Transform Infrared Spectroscopy (FTIR), ASTM E1252, 400 cm^{-1} to 4000 cm^{-1} .
- Differential Scanning Calorimetry (DSC) thermogram, ISO 11357-1, -40 °C to 300 °C.
- Thermogravimetric Analysis (TGA) thermogram, ISO 11358, room temperature to 900 °C.

3.9 Requirements on Delivery. Lot release certificate as specified in the accompanied GMW Plastic Submission Template shall accompany each shipment.

3.10 Performance Requirements. Performance requirements shall be specified on part drawings or in component specifications, including colors.

3.11 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.

Table 1: Requirements for Reinforced Flame Resistant Polyamide for High Voltage Insulation

Property	Test Method	Unit	Type AF
ISO Symbol for Material	ISO 1043-1		PA66/6T-GF25FR(40)
ISO Symbol for Part	ISO 11469		PA66/6T-GF25FR(40)
Density	ISO 1183	g/cm^3	1.44 ± 0.03
Ash	ISO 11358 in air or ISO 3451-4	%	32 ± 3
Moisture Content	ISO 15512 Method A or B	%	≤ 0.2
Tensile Modulus	ISO 527-1/ISO 527-2	MPa	≥ 8500
Tensile Elongation	ISO 527-1/ISO 527-2	%	≥ 1.7