



UNSATURATED POLYESTER (UP) INJECTION MOLDING COMPOUND, 14% GLASS FIBER REINFORCED, EXTERIOR APPLICATIONS, HIGH FILL CONTENT

WSS-M3D178-A3

1. SCOPE

The material defined by these specifications is a glass fiber reinforced thermosetting injection molding compound based on unsaturated polyester resin (UP), for exterior applications only.

2. APPLICATION

These specifications were released originally for material used for complex reflector bodies for exterior lighting.

2.1 LIMITATIONS

Due to the high levels of Calcium Carbonate, CaCO_3 , these materials are hydroscopic and need to be coated.

3. REQUIREMENTS

3.1 STANDARD REQUIREMENTS FOR PRODUCTION MATERIALS

Material suppliers and part producers must conform to the Company's Standard Requirements For Production Materials (WSS-M99P1111-A).

3.1.1 Note: Many 4D resin specifications prior to 2011, identified certain requirements with the symbol (s), which indicated that the mean and +/- 3 sigma values were to be reported. The specification minimum, maximum or range was established using 3 sigma values. For 2011 and beyond, refer to Table 1 for number of samples required for each test.

3.1.2 This specification is based on virgin material and does not allow the addition of, recycled content (PIR/PCR).

3.1.3 Materials containing recycled content (PIR/PCR) must be specified with a Ford WRS material specification as defined by WRS-M99P42-A1. These materials cannot be substituted without prior Ford approval and addition of the WRS specification to the engineering drawing.

3.1.4 Performance Criteria:
Parts using this specification shall meet the appropriate performance specification, WSS-M98P10-A/Latest.

3.1.5 As specified in WSS-M99P1111-A, paragraph 3.2, Ford Materials Engineering may request a Control Plan and Certificate of Analysis (CoA) containing lot testing requirements which must include, but are not limited to:

Density
Determination of Ash

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- 3.1.7 Dry as molded:
All test values indicated herein are based on material and specimens with moisture content not exceeding 2.0% except where noted.

All test materials have to be sealed in moisture-proof containers and stored at 23 ± 2 °C for at least 24 h immediately after processing. If the moisture content exceeds 0.2%, conditioning the material for a minimum of 16 h at $40 - 50$ °C at a reduced pressure below 133 kPa.

Conduct tests in a controlled atmosphere of 23 ± 2 °C and $50 \pm 5\%$ relative humidity. Individual specimens shall not be removed from closed containers until immediately before testing.

3.2 SAMPLE PREPARATION

Unless otherwise specified all tests shall be carried out on injection molded, one-end gated test specimens. The test specimens A and D shall be molded using molding conditions defined in ISO 1872-2 or injection molded ISO multipurpose specimen per ISO 3167. No annealing is allowed. See Tables 1 and 2 for the number of samples required.

Specimens shall be as follows:

Specimen A	150 minimum x 10 x 4.0 $\pm$ 0.2 mm (ISO 527-2, Specimen Type 1A)
Specimen B	355 x 100 x 1.0 $\pm$ 0.1 mm (ISO 3795)
Specimen C	145 x 60 x 3.2 $\pm$ 0.2 mm
Specimen D	Center of Specimen A, 80 x 10 x 4.0 $\pm$ 0.2 mm
Specimen E	100 mm diameter x 3.2 mm
Specimen F	80 mm diameter x 3.2 mm
Specimen G	90 mm x 200 mm
Specimen H	50 $\pm$ 1 mm diameter x 3.2 $\pm$ 0.2 mm
Specimen I	100 mm x 150 mm, min

3.3 MOLDING COMPOUND

3.3.1 Filler Content

- 3.3.1.1 Determination of Ash (Filler + Glass Fiber) 70 – 80 %
(ISO 3451-1, Method A, or
ISO 3451-2, 1 h at 650 ± 25 °C)

- 3.3.1.2 Glass Fiber Content 12 – 16 by weight %

Test Method: ISO 3451/1, Method B, 1 h at 650 ± 25 °C, except use 5% by volume hydrochloric acid solution for 15 minutes. Rinse the glass fibers several times with distilled water before drying in an oven for 2 h at 120 ± 2 °C. After cooling, weigh the crucibles and calculate the percent glass fibers.

NOTE: The glass fiber/mineral content is reported as a range which accommodates the variation due to the pigment loading.

- 3.3.2 Density, 1.95 – 2.1 g/cm³
(ISO 1183, Method A)



3.3.3	Tensile Strength at Max Load, (ISO R 527, Specimen A, 5 mm/min test speed)	14.0 MPa, min
3.3.4	Tensile Modulus (ISO 527-1 and ISO 527-2, Specimen A, (range) 1 mm/minute test speed)	14 GPa min
3.3.5	Flexural Modulus, (ISO 178, Specimen D, 2 mm/min test speed, 64 mm support span)	10.0 GPa, min
3.3.6	Flexural Strength (ISO 178, Specimen D, 2 mm/min test speed, 64 mm support span)	35 MPa, min
3.3.7	Impact Strength, Notched Charpy (ISO 179-1/1eA, Specimen D)	
3.3.7.1	At 23 +/- 2 °C	10 kJ/m ² min
3.3.7.2	At -40 +/- 2 °C	11 kJ/m ² min
The test specimen must be conditioned for minimum of 6 hours at the above specified temperature prior to impact test. Low temperature testing shall be done within the cold chamber, if not possible, test may be conducted outside, but within 5 seconds.		
3.3.8	Heat Deflection Temperature (ISO 75, Specimen D, edgewise, 0.32 +/- 0.01 mm deflection. At 1.80 MPa)	255 °C, min
3.3.9	Water Absorption (ISO 62, 24 h, boiling water, Specimen A)	2.0 %, max
3.3.10	Heat Aging Performance (ISO 188, except 150 +/- 50 air changes/h, 1000 h at 150 +/- 2 °C) Unaged property values shall be determined at the time of the aged properties determination.	
3.3.10.1	Tensile Strength at Max Load Change (Test Method per para 3.3.3)	+/- 25%
3.3.10.2	Flexural Strength Change (Test Method per para 3.3.6)	+/- 25%
3.3.10.3	Impact Strength, Charpy Change (Test Method per para 3.3.7, specimens to be notched before heat aging)	+/- 25%