

SEMI G11-88 (Reapproved 0811) RECOMMENDED PRACTICE FOR RAM FOLLOWER GEL TIME AND SPIRAL FLOW OF THERMAL SETTING MOLDING COMPOUNDS

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NOTICE: This Document was reapproved with minor editorial changes.

1 Scope

1.1 This method describes a procedure for measuring the flow and gel characteristics of semiconductor grade transfer molding compounds using a ram follower device.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

2 Referenced Standards and Documents

2.1 *ASTM Standard*¹

ASTM D3123 — Plastics, Molding, and Extrusions

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

3 Significance

3.1 The flow of a molding compound depends on the interaction of several variables, and is a measure of the combined characteristics of speed of gelation and melt viscosity of the particular compound under the specified conditions. The test is not a valid method for comparing the moldability of different compounds since a spiral flow test cannot duplicate actual molding conditions in different types of molds.

3.2 The moldability of thermosetting molding compounds has generally been defined by a single spiral flow number. The ram follower device follows graphically the molding compound as it melts and the rate of flow increases, as viscosity builds up due to resin polymerization, and as the flow of the compound ceases. Thus, it measures the gelation point of the compound, or the point where the material ceases to flow. This information can be an aid in characterizing the rheological behavior of the molding compound.

4 Apparatus

4.1 *Transfer Molding Press* — With a platen area sufficient to maintain a uniform mold temperature and having (1) a transfer piston pressure potential of 1000 psi on the material; (2) sufficient clamping pressure to prevent flashing of the molding compound; and (3) a minimum plunger speed of 25.4 mm (1 in.) per second without load. The pot diameter shall be 31.75 to 44.45 ± 0.635 mm (1.250 to 1.750 ± 0.025 in.) and the clearance between pot and ram shall be sufficiently small that flashing does not occur above the first sealing groove on the ram.

4.2 *Standard Spiral Flow Mold* — Per ASTM D3123.

4.3 *Ram Following Apparatus* — Consisting of a displacement transducer attached to the transfer ram of the press in such a way as to accurately record its movement, suitable power supply for the displacement transducer, and a recorder capable of recording the signal from the displacement transducer and preferably having a chart speed of at least 10 mm per second. An optional velocity transducer can also be used as a means of directly measuring ram velocity and verifying the starting and ending of the flow process. In this case, a 2-channel recorder is needed.

4.4 *Thermocouple and Potentiometer* — Calibrated in the 149°C to 177°C (300°F to 350°F) range. (Calibration to be checked every six months.)

¹ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; Telephone: +1.610.832.9585, Fax: +1.610.832.9555, <http://www.astm.org>

5 Test Conditions

5.1 *Molding Compound* — Refrigerated shipment and storage of some molding compounds is necessary. The molding compound is to be at room temperature before the container is opened. Once the compound has equilibrated to room temperature, the test should be run within 16 hours. Care must be taken to preserve the original moisture content. The material should be in powdered form, unless otherwise specified.

NOTE 1: Room temperature defined to be $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

NOTE 2: Refer to manufacturers' recommendations regarding shelf life differences which may exist between molding compounds.

5.2 *The Spiral Flow Mold* — Shall be clean and free from any mold release agents or lubricants. A standard mold cleaning compound can be used to insure mold cleanliness.

5.3 Molding Conditions

5.3.1 The temperature of the mold shall be measured using a thermocouple inserted in the mold. The ram shall be kept at the mold temperature. Molding temperature is to be as recommended by the material specification unless otherwise specified. Temperature must be maintained within $\pm 3^{\circ}\text{C}$ ($\pm 5^{\circ}\text{F}$) of the specified temperature.

NOTE 3: Flow duration is strongly influenced by temperature. For critical determinations, the temperature should be maintained as close to the nominal temperature as practical, preferably within $\pm 0.5^{\circ}\text{C}$ ($\pm 1^{\circ}\text{F}$).

5.3.2 The weight of the charge shall be adjusted to give a molded cull thickness of 3.302 ± 0.254 mm (0.130 ± 0.010 in.), excluding vertical flash.

5.3.3 The free running ram speed shall be at least 25.4 mm/sec (1 in./sec). Recommended speed is 100 ± 25 mm/sec into the pot and application of pressure on the charge shall not exceed 5 seconds.

5.3.4 The transfer pressure measured under the transfer plunger is to be 6.895 ± 0.177 mPa (1000 ± 25 psi) unless otherwise specified.

5.3.5 Unless otherwise specified, a minimum of 1.5 minutes close and cure time shall be used.

5.4 *Flow Length* — Read the spiral flow length directly from the molded specimen at the point of farthest continuous flow to the nearest 6.35 mm (0.25 in.).

5.5 *Flow Duration* — The flow duration or gel time is defined as the time interval between the moment when the ram contacts the charge and the time the ram stops moving. The contact and gelation points are determined from the ram follower trace.

6 Procedure for Spiral Flow

6.1 Thoroughly clean the ram, pot, and mold of any cured compound, or other foreign matter.

6.2 Heat the mold and ram to within ($\pm 3^{\circ}\text{C}$) of the specified temperature.

6.3 At the beginning of each series of tests and at each change of compound, check and set the transfer pressure using the force gage. The proper force gage setting can be determined from the formula:

$$F = \frac{\pi D^2 P}{4}$$

where F is the force in pounds, P is the desired pressure on the material in psi and D is the ram diameter in inches.

6.4 For each material change, make at least three "clean out" runs using the material to be tested before recording data. These runs may be used to determine the charge weight.

6.5 Weigh out the compound to the nearest 0.1 g as previously determined to yield a cull of 3.302 ± 0.254 mm (0.130 ± 0.010 in.).

6.6 Raise the ram, add the compound to the pot, and immediately activate the transfer cycle. If the recorder does not have a remote on-off that is activated by the cycle start, then it should be started before the cycle starts. After the ram motion ceases, the chart may be stopped.

6.7 Open mold and remove cured material. Measure cull thickness. If the cull is not within 3.302 ± 0.254 mm (0.130 ± 0.010 in.), discard run and repeat the test, adjusting the charge weight as necessary.