



Designation: D5279 – 21

## Standard Test Method for Plastics: Dynamic Mechanical Properties: In Torsion<sup>1</sup>

This standard is issued under the fixed designation D5279; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This test method covers the use of dynamic mechanical instrumentation for gathering and reporting the viscoelastic properties of thermoplastic and thermosetting resins and composite systems in the form of rectangular specimens molded directly or cut from sheets, plates, or molded shapes. The torsional data generated may be used to identify the thermomechanical properties of a plastics material or composition.

1.2 This test method is intended to provide means for determining the torsional modulus of plastics as a function of temperature using nonresonant forced-vibration techniques, as outlined in Practice D4065. Plots of the elastic (storage), loss (viscous), and complex moduli and tan delta, as a function of frequency, time, or temperature are indicative of significant transitions in the thermomechanical performance of the polymeric material system.

1.3 This test method is valid for a wide range of frequencies, typically from 0.01 to 100 Hz.

1.4 Apparent discrepancies may arise in results obtained under differing experimental conditions. These apparent differences from results observed in another study can usually be reconciled without changing the observed data by reporting in full (as described in this test method) the conditions under which the data were obtained.

1.5 Test data obtained by this test method are relevant and appropriate for use in engineering design.

1.6 The values stated in SI units are to be regarded as standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This test method is equivalent to ISO 6721, Part 7.

1.8 *This international standard was developed in accordance with internationally recognized principles on standard-*

*ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 ASTM Standards:<sup>2</sup>

D618 Practice for Conditioning Plastics for Testing

D4065 Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures

D4092 Terminology for Plastics: Dynamic Mechanical Properties

### 3. Terminology

3.1 For definitions applicable to this test method, refer to Terminology D4092.

### 4. Summary of Test Method<sup>3</sup>

4.1 This test method covers the determination of the shear modulus of plastics using dynamic mechanical techniques. A test specimen of rectangular cross section is tested in dynamic torsion. The specimen is gripped longitudinally between two clamps. The specimen of known geometry is placed in mechanical torsional displacement at either a fixed frequency, or variable frequencies at either isothermal conditions, or with a linear temperature increase. The elastic or loss modulus, or both, of the polymeric material system are measured in torsion.

### 5. Significance and Use

5.1 This test method provides a simple means of characterizing the thermomechanical behavior of plastics material. The data obtained may be used for quality control, research and development, and establishment of optimum processing conditions.

5.2 Dynamic mechanical testing provides a sensitive method for determining thermomechanical characteristics by measuring the elastic and loss moduli as a function of

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The particular method for measurement of the elastic and loss moduli and tan delta depends upon the individual instrument's operating principles.

\*A Summary of Changes section appears at the end of this standard

frequency, temperature, or time. Plots of moduli and tan delta of a material versus temperature provide graphical representations indicative of physical and mechanical properties, effectiveness of cure (thermosetting resin system), and damping behavior under specified conditions.

5.3 This test method can be used to assess

5.3.1 The modulus as a function of temperature,

5.3.2 The modulus as a function of frequency,

5.3.3 The effects of processing treatment, including orientation,

5.3.4 Relative resin behavioral properties, including cure and damping,

5.3.5 The effects of substrate types and orientation (fabrication) on elastic modulus, and

5.3.6 The effects of formulation additives that might affect processability or performance.

5.4 Before proceeding with this test method, reference should be made to the specification of the material being tested. Any test specimen preparation, conditioning, dimensions, or testing parameters, or combination thereof, covered in the relevant ASTM materials specification shall take precedence over those mentioned in this test method. If there are no relevant ASTM materials specifications, then the default conditions apply.

## 6. Interferences

6.1 Since small test specimen geometries are used, it is essential that the specimens be representative of the material being tested.

## 7. Apparatus

7.1 The function of the apparatus is to hold a rectangular test specimen so that the material acts as the elastic and dissipative element in a mechanically driven torsional system. Dynamic mechanical instruments operate at a forced, constant amplitude, and either at a fixed frequency, or variable frequencies.

7.2 The apparatus shall consist of the following:

7.2.1 *Fixed Member*—A fixed or essentially stationary member carrying one grip.

7.2.2 *Movable Member*—A movable member carrying a second grip.

7.2.3 *Grips*—Grips for holding the test specimen between the fixed member and the movable member. The grips shall be mechanically aligned, that is, they shall be attached to the fixed and movable member, respectively, in such a manner that they will move into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied pull through the center line of the grip assembly.

7.2.3.1 The test specimen shall be held in such a way that slippage relative to the grips is minimized.

7.2.4 *Deformation (Strain Device)*—A device for applying a continuous linear deformation (strain) to the specimen. In the force-displacement device the deformation (strain) is applied and then released. (See Table 1 of Practice [D4065](#).)

7.2.5 *Detectors*—Devices for determining dependent and independent experimental parameters, such as force (stress),

deformation (strain), frequency, and temperature. Temperature should be measurable with a precision of  $\pm 1^\circ\text{C}$ , frequency to  $\pm 1\%$ , and force to  $\pm 1\%$ .

7.2.6 *Temperature Controller and Oven*—A device for controlling the temperature, either by heating (in steps or ramps), cooling (in steps or ramps), maintaining a constant specimen environment, or a combination thereof. A temperature controller should be sufficiently stable to permit measurement of environmental chamber temperature to within  $1^\circ\text{C}$ .

7.3 Nitrogen or other inert gas supply for purging purposes.

## 8. Test Specimens

8.1 Any rectangular specimen, representative of the material being tested and within the fixturing capabilities of the specific test instrument employed, shall be used so long as an accurate description of the specimen is clearly stated in the test report.

NOTE 2—The test specimens may be cut from sheets, plates, or molded shapes, or may be molded to the desired finished dimensions.

## 9. Calibration

9.1 Calibrate the instrument using procedures recommended by the manufacturer.

## 10. Conditioning

10.1 *Conditioning*—Condition the test specimens at  $23.0 \pm 2.0^\circ\text{C}$  and  $50 \pm 5\%$  relative humidity for not less than 40 h prior to testing in accordance with Procedure A of Practice [D618](#), unless otherwise specified by the contract or relevant material specification.

## 11. Procedure

11.1 Use an untested specimen for each measurement. Measure the width and thickness of the specimen to the nearest 0.03 mm at the center of the specimen and enter those dimensions into the test program using the instrument's software.

11.2 Clamp the test specimen between the movable and stationary members using shim stock, if necessary, to minimize slippage within the clamp.

11.3 Preload the test specimen so that a positive normal force is maintained during the test. Monitor the normal force during testing to ensure adequate preloading.

11.4 Measure the jaw separation between the movable and stationary members to the nearest 0.03 mm and enter that dimension into the test program using the instrument's software.

NOTE 3—Tests may be conducted in several modes depending on the desired characterization requirements and the properties of interest. Generally those modes include a strain sweep during which the temperature and frequency are maintained at constant values; a frequency sweep during which the temperature and strain are maintained at constant values; a temperature sweep during which the strain and frequency are maintained at constant values or a frequency-temperature sweep during which the strain is maintained at a constant value and properties are measured across a range of frequencies at step increments of temperature.

11.5 Based on the type of test being conducted: