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Standard Test Method for Plastics: Dynamic Mechanical Properties: In Torsion[1]

This standard is issued under the fixed designation D 5279; 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 (ε) 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 ~~of plastics~~ using nonresonant forced-vibration techniques, as outlined in Practice D 4065. 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 and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE ~~1—There is no similar or equivalent ISO standard.~~ 1—This test method is equivalent to ISO 6721, Part 7.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 618~~Practice for Conditioning Plastics and Electrical Insulating Materials for Testing~~ Practice for Conditioning Plastics for Testing

D 4065~~Practice for Determining and Reporting Dynamic Mechanical Properties of Plastics~~ Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures

D 4092~~Terminology Relating to Dynamic Mechanical Measurements of Plastics~~[3] Terminology for Plastics: Dynamic Mechanical Properties

3. Terminology

3.1 For definitions applicable to this test method, refer to Terminology D 4092.

4. Summary of Test Method [3]

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.

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[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.
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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* ~~, Vol 08.01.~~volume information, refer to the standard's Document Summary page on the ASTM website.

[3] ~~Annual Book of ASTM Standards, Vol 08.02.~~

[3] 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.**

5. Significance and Use

5.1 This test method provides a simple means of characterizing the thermomechanical behavior of plastics materials using very small amounts of 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 frequency, temperature, or time. Plots of moduli and tan delta of a material versus temperature provide graphical representations indicative of functional 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 D 4065.)

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 ±1°C, frequency to ±1 %, and force to ±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°C.

7.3 Nitrogen or other inert gas supply for purging purposes.

8. ~~Test Specimens~~

~~8.1The specimens may be cut from sheets, plates or molded shapes, or may be molded to the desired finished dimensions. Typically, the rectangular test specimen is 76 by 13 by 3 mm. Rectangular test specimens of other dimensions can be used but should be clearly identified in the report section. The distance between grips is approximately 64 mm.~~ Test Specimens

8.1 The specimens may be cut from sheets, plates or molded shapes, or may be molded to the desired finished dimensions. Any rectangular specimen, representative of the material being tested and within the fixturing capabilities of the specific test instrument being used, may be used as long as it is clearly stated in the test report.

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 ± 2.0°C and 50 ± 5 % relative humidity for not ~~fewer~~less than 40