Designation: D 4440 – 95a

An American National Standard

# Standard Practice for Rheological Measurement of Polymer Melts Using Dynamic Mechanical Procedures[1]

This standard is issued under the fixed designation D 4440; 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 practice covers the use of dynamic mechanical instrumentation[2] for use in gathering and reporting the rheological properties of thermoplastic resins. It may be used as a practice for determining the complex viscosity and significant viscoelastic characteristics of such materials as a function of frequency, strain amplitude, temperature, and time. Such properties may be influenced by fillers and other additives.

1.2 It incorporates a laboratory practice for determining the relevant rheological properties of a polymer melt subjected to various oscillatory deformations on an instrument of the type commonly referred to as mechanical or dynamic spectrometer.

1.3 This practice is intended to provide means of determining the rheological properties of molten polymers, such as thermoplastics and thermoplastic elastomers over a range of temperatures by nonresonant forced-vibration techniques. Plots of modulus, viscosity, and tan delta as a function of dynamic oscillation (frequency), strain amplitude, temperature, and time are indicative of the viscoelastic properties of a molten polymer.

1.4 This practice is valid for a wide range of frequencies, typically from 0.01 to 100 Hz.

1.5 This practice is intended for homogenous and heterogenous molten polymeric systems and composite formulations containing chemical additives, including fillers, reinforcements, stabilizers, plasticizers, flame retardants, impact modifiers, processing aids, and other important chemical additives often incorporated into a polymeric system for specific functional properties, and which could affect the processability and functional performance. These polymeric material systems have molten viscosities less than $10^6$ Pa·s ($10^7$ poise).

1.6 Apparent discrepancies may arise in results obtained under differing experimental conditions. Without changing the observed data, reporting in full (as described in this practice) the conditions under which the data were obtained will enable apparent differences observed in another study to be reconciled.

1.7 Test data obtained by this practice is relevant and appropriate for use in engineering design.

1.8 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.9 *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.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 4000 Classification System for Specifying Plastic Materials[3]

D 4065 Practice for Determining and Reporting Dynamic Mechanical Properties of Plastics[3]

D 4092 Terminology Relating to Dynamic Mechanical Measurements on Plastics[3]

## 3. Terminology

3.1 *Definitions:* Definitions are in accordance with Terminology D 4092.

## 4. Summary of Practice

4.1 A known amount of thermoplastic resin (molten powder or pellet, or solid preform disk) is placed in mechanical oscillation at a fixed or varying frequency at isothermal conditions or over a linear temperature increase or a time-temperature relation simulating a processing condition. Storage (elastic) G′ or loss (viscous) moduli, G′′, or both, or the corresponding dynamic viscosity functions $n' = g''/w$ and $n'' = g'/w$, of the polymeric material specimen are measured in shear as a function of frequency, strain, temperature, or time.

## 5. Significance and Use

5.1 This practice provides a simple means of characterizing the important rheological properties and viscosity of thermoplastic resins using very small amounts of material (approximately 25 to 50 mm in diameter by 1 to 3 mm in thickness ... approximately 3 to 5 g). Data may be used for quality control, research and development, and establishment of optimum

[1] This practice is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

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[2] Dynamic Mechanical Instrumentation is available from Rheometrics, Inc., Piscataway, NJ 08854 and The Perkin-Elmer Corp., 761 Main Avenue, Norwalk, CT 06859-0256, (203) 762-1000.

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