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BSI Standards Publication

Plastics — Determination of the transient extensional viscosity of polymer melts

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National foreword

This British Standard is the UK implementation of ISO 20965:2021. It supersedes BS ISO 20965:2005, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/21, Testing of plastics.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Plastiques — Détermination de la viscosité élongationelle transitoire des polymères à l'état fondu

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Phone: +41 22 749 01 11
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

This second edition cancels and replaces the first edition (ISO 20965:2005), which has been technically revised.

The main changes compared to the previous edition are as follows:

— figures have been updated and figure keys have been introduced;

— calibration period in 5.6 has been clarified.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Plastics — Determination of the transient extensional viscosity of polymer melts

1 Scope

This document specifies the general principles of a method for determining the transient extensional viscosity of polymer melts. The procedure details the measurement of polymer melt specimens stretched uniaxially under conditions of constant strain rate and constant temperature.

The method is capable of measuring the transient extensional viscosity of polymer melts at Hencky strain rates typically in the range 0,01 s^{-1} to 1 s^{-1}, at Hencky strains up to approximately 4 and at temperatures up to approximately 250 °C (see NOTEs 1 and 2). It is suitable for measuring transient extensional viscosity values typically in the range from approximately 10^4 Pa·s to 10^7 Pa·s (see NOTE 3).

NOTE 1 Hencky strains and strain rates are used (see Clause 3).

NOTE 2 Values of strain, strain rate and temperature outside these limiting values can be attained.

NOTE 3 The operating limit of an instrument, in terms of the lowest transient extensional viscosity values that can be measured, is due to a combination of factors, including the ability of the specimen to maintain its shape during testing and the resolution of the instrument.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 472, *Plastics — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
Hencky strain
ε
strain given by the natural logarithm of the elongation ratio given by Formula (1)

$$\varepsilon = \mathrm{In}\left(l / l_0\right) \tag{1}$$

where

l is the specimen length and

l_0 is the original specimen length

Note 1 to entry: It is also referred to as the natural or true strain.

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Note 2 to entry: It is dimensionless.

3.2
Hencky strain rate
ε
rate of change of Hencky strain with time, given by Formula (2)

$$\varepsilon = 1/l \times \partial l/\partial t \tag{2}$$

where t is the time

Note 1 to entry: It is independent of the original specimen length l_0.

Note 2 to entry: It is expressed in reciprocal seconds.

3.3
net tensile stress
σ_E
for tensile uniaxial extension, stress given by Formula (3)

$$\sigma_E = \sigma_{11} - \sigma_{22} = \sigma_{11} - \sigma_{33} = \sigma_{zz} - \sigma_{rr} \tag{3}$$

where σ_{ii} is a stress tensor in either rectangular or axisymmetric co-ordinates

Note 1 to entry: The tensile stress growth function is indicated by $\sigma_E{}^+$ where the $^+$ indicates start-up of flow.

Note 2 to entry: Net tensile stress is expressed in pascals.

3.4
tensile stress growth coefficient
$\eta_E{}^+$
ratio of the net tensile stress to the Hencky strain rate, given by Formula (4)

$$\eta_E{}^+(t,\varepsilon) = \sigma_E/\varepsilon \tag{4}$$

for tensile uniaxial extension, where t is time and $^+$ indicates start-up of flow

Note 1 to entry: It is also known for the purposes of this document as “transient extensional viscosity”.

Note 2 to entry: It is a transient term.

Note 3 to entry: It is expressed in pascal seconds.

3.5
tensile viscosity
η_E
term given by Formula (5)

$$\eta_E(t,\varepsilon) = \lim_{t\to\infty}\left[\eta_E^+(t,\varepsilon)\right] \tag{5}$$

Note 1 to entry: It is the limiting tensile stress growth coefficient value and represents an equilibrium extensional viscosity if a steady value is achieved. However, for materials that do not exhibit a steady-state behaviour, the use of an “equilibrium extensional viscosity” such as this is not appropriate.

Note 2 to entry: It is expressed in pascal seconds.

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