SLOVENSKI STANDARD
SIST EN ISO 6721-1:2003

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Nadomeġļ a:
SIST EN ISO 6721-1:1999
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Polimerni materiali - Doloļ anje dinamiļ nih mehanskih lastnosti - 1. del: Sploġna naļ ela (ISO 6721-1:2001)

Plastics - Determination of dynamic mechanical properties - Part 1: General principles (ISO 6721-1:2001)

Kunststoffe - Bestimmung dynamisch-mechanischer Eigenschaften - Teil 1: Allgemeine Grundlagen (ISO 6721-1:2001)

Plastiques - Détermination des propriétés mécaniques dynamiques - Partie 1: Principes généraux (ISO 6721-1:2001)

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EN ISO 6721-1

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English version

Plastics - Determination of dynamic mechanical properties - Part 1: General principles (ISO 6721-1:2001)

Plastiques - Détermination des propriétés mécaniques dynamiques - Partie 1: Principes généraux (ISO 6721-1:2001)

Kunststoffe - Bestimmung dynamisch-mechanischer Eigenschaften - Teil 1: Allgemeine Grundlagen (ISO 6721-1:2001)

This European Standard was approved by CEN on 19 August 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN ISO 6721-1:2002 E

Foreword

The text of ISO 6721-1:2001 has been prepared by Technical Committee ISO/TC 61 "Plastics" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 6721-1:2002 by Technical Committee CEN/TC 249 "Plastics", the secretariat of which is held by IBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2003, and conflicting national standards shall be withdrawn at the latest by March 2003.

This document supersedes EN ISO 6721-1:1996.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 6721-1:2001 has been approved by CEN as a European Standard without any modifications.

NOTE Normative references to International Standards are listed in annex ZA (normative).

Annex ZA
(normative)

Normative references to international publications with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE Where an International Publication has been modified by common modifications, indicated by (mod.), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
ISO 291	1997	Plastics - Standard atmospheres for conditioning and testing	EN ISO 291	1997
ISO 294-1	1996	Plastics - Injection moulding of test specimens of thermoplastic materials - Part 1: General principles, and moulding of multipurpose and bar test specimens	EN ISO 294-1	1998
ISO 294-2	1996	Plastics - Injection moulding of test specimens of thermoplastic materials - Part 2: Small tensile bars	EN ISO 294-2	1998
ISO 294-3	1996	Plastics - Injection moulding of test specimens of thermoplastic materials - Part 3: Small plates	EN ISO 294-3	1998
ISO 294-4	1996	Plastics - Injection moulding of test specimens of thermoplastic materials - Part 4: Determination of moulding shrinkage	EN ISO 294-4	1998
ISO 295	1991	Plastics - Compression moulding of test specimens of thermosetting materials	EN ISO 295	1998
ISO 2818	1994	Plastics - Preparation of test specimens by machining	EN ISO 2818	1996
ISO 6721-2	1994	Plastics - Determination of dynamic mechanical properties - Part 2: Torsion-pendulum method	EN ISO 6721-2	1996
ISO 6721-3	1994	Plastics - Determination of dynamic mechanical properties - Part 3: Flexural vibration - Resonance-curve method	EN ISO 6721-3	1996

INTERNATIONAL STANDARD

ISO 6721-1

Second edition
2001-05-15

Plastics — Determination of dynamic mechanical properties —

Part 1: General principles

Plastiques — Détermination des propriétés mécaniques dynamiques —

Partie 1: Principes généraux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 6721 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6721-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 6721-1:1994), of which it constitutes a minor revision (two further references have been added to the bibliography).

ISO 6721 consists of the following parts, under the general title *Plastics — Determination of dynamic mechanical properties*:

— *Part 1: General principles*
— *Part 2: Torsion-pendulum method*
— *Part 3: Flexural vibration — Resonance-curve method*
— *Part 4: Tensile vibration — Non-resonance method*
— *Part 5: Flexural vibration — Non-resonance method*
— *Part 6: Shear vibration — Non-resonance method*
— *Part 7: Torsional vibration — Non-resonance method*
— *Part 8: Longitudinal and shear vibration — Wave-propagation method*
— *Part 9: Tensile vibration — Sonic-pulse propagation method*
— *Part 10: Complex shear viscosity using a parallel-plate oscillatory rheometer*

Additional parts are planned.

Annexes A and B of this part of ISO 6721 are for information only.

Introduction

The methods specified in the first nine parts of ISO 6721 can be used for determining storage and loss moduli of plastics over a range of temperatures or frequencies by varying the temperature of the specimen or the frequency of oscillation. Plots of the storage or loss moduli, or both, are indicative of viscoelastic characteristics of the specimen. Regions of rapid changes in viscoelastic properties at particular temperatures or frequencies are normally referred to as transition regions. Furthermore, from the temperature and frequency dependencies of the loss moduli, the damping of sound and vibration of polymer or metal-polymer systems can be estimated.

Apparent discrepancies may arise in results obtained under different experimental conditions. Without changing the observed data, reporting in full (as described in the various parts of ISO 6721) the conditions under which the data were obtained will enable apparent differences observed in different studies to be reconciled.

The definitions of complex moduli apply exactly only to sinusoidal oscillations with constant amplitude and constant frequency during each measurement. On the other hand, measurements of small phase angles between stress and strain involve some difficulties under these conditions. Because these difficulties are not involved in some methods based on freely decaying vibrations and/or varying frequency near resonance, these methods are used frequently (see ISO 6721-2 and ISO 6721-3). In these cases, some of the equations that define the viscoelastic properties are only approximately valid.

Plastics — Determination of dynamic mechanical properties —

Part 1:
General principles

1 Scope

The various parts of ISO 6721 specify methods for the determination of the dynamic mechanical properties of rigid plastics within the region of linear viscoelastic behaviour. This part of ISO 6721 is an introductory section which includes the definitions and all aspects that are common to the individual test methods described in the subsequent parts.

Different deformation modes may produce results that are not directly comparable. For example, tensile vibration results in a stress which is uniform across the whole thickness of the specimen, whereas flexural measurements are influenced preferentially by the properties of the surface regions of the specimen.

Values derived from flexural-test data will be comparable to those derived from tensile-test data only at strain levels where the stress-strain relationship is linear and for specimens which have a homogeneous structure.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6721. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6721 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing*.

ISO 293:1986, *Plastics — Compression moulding test specimens of thermoplastic materials*.

ISO 294 (all parts), *Plastics — Injection moulding of test specimens of thermoplastic materials*.

ISO 295:1991, *Plastics — Compression moulding of test specimens of thermosetting materials*.

ISO 1268 (all parts), *Plastics — Methods of producting test plates*.

ISO 2818:1994, *Plastics — Preparation of test specimens by machining*.

ISO 4593:1993, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning*.

ISO 6721-2:1994, *Plastics — Determination of dynamic mechanical properties — Part 2: Torsion-pendulum method.*

ISO 6721-3:1994, *Plastics — Determination of dynamic mechanical properties — Part 3: Flexural vibration — Resonance-curve method*.

3 Terms and definitions

For the purposes of this part of ISO 6721, the following terms and definitions apply.

NOTE Most of the terms defined here are also defined in ISO 472:1999, *Plastics — Vocabulary*. The definitions given here are not strictly identical with, but are equivalent to, those in ISO 472:1999.

3.1
complex modulus
M^*
the ratio of dynamic stress, given by $\sigma(t) = \sigma_A \exp(i2\pi ft)$, and dynamic strain, given by $\varepsilon(t) = \varepsilon_A \exp[i(2\pi ft - \delta)]$, of a viscoelastic material that is subjected to a sinusoidal vibration, where σ_A and ε_A are the amplitudes of the stress and strain cycles, f is the frequency, δ is the phase angle between stress and strain (see 3.5 and Figure 1) and t is time

It is expressed in Pascals (Pa).

Depending on the mode of deformation, the complex modulus may be one of several types: E^*, G^*, K^* or L^* (see Table 3).

$$M^* = M' + iM'' \qquad \text{(see 3.2 and 3.3)} \tag{1}$$

where

$$i = (-1)^{1/2} = \sqrt{-1}$$

For the relationships between the different types of complex modulus, see Table 1.

NOTE 1 For isotropic viscoelastic materials, only two of the elastic parameters G^*, E^*, K^*, L^* and μ^* are independent (μ^* is the complex Poisson's ratio, given by $\mu^* = \mu' + \mu''$).

NOTE 2 The most critical term containing Poisson's ratio μ is the "volume term" $1 - 2\mu$, which has values between 0 and 0,4 for μ between 0,5 and 0,3. The relationships in Table 1 containing the "volume term" $1 - 2\mu$ can only be used if this term is known with sufficient accuracy.

It can be seen from Table 1 that the volumetric term $1 - 2\mu$ can only be estimated with any confidence from a knowledge of the bulk modulus K or the uniaxial-strain modulus L and either E or G. This is because K and L measurements involve deformations when the volumetric strain component is relatively large.

NOTE 3 Up to now, no measurement of the dynamic mechanical bulk modulus K, and only a small number of results relating to relaxation experiments measuring $K(t)$, have been described in the literature.

NOTE 4 The uniaxial-strain modulus L is based upon a load with a high hydrostatic-stress component. Therefore values of L compensate for the lack of K values, and the "volume term" $1 - 2\mu$ can be estimated with sufficient accuracy based upon the modulus pairs (G, L) and (E, L). The pair (G, L) is preferred, because G is based upon loads without a hydrostatic component.

NOTE 5 The relationships given in Table 1 are valid for the complex moduli as well as their magnitudes (see 3.4).

NOTE 6 Most of the relationships for calculating the moduli given in the other parts of this International Standard are, to some extent, approximate. They do not take into account e.g. "end effects" caused by clamping the specimens, and they include other simplifications. Using the relationships given in Table 1 therefore often requires additional corrections to be made. These are given in the literature (see e.g. references [1] and [2] in the Bibliography).

NOTE 7 For linear-viscoelastic behaviour, the complex compliance C^* is the reciprocal of the complex modulus M^*, i.e.

$$M^* = (C^*)^{-1} \tag{2}$$