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Plastics — Determination of dynamic mechanical properties —

Part 8: Longitudinal and shear vibration — Wave-propagation method

Plastiques — Détermination des propriétés mécaniques dynamiques —

Partie 8: Vibrations longitudinale et en cisaillement — Méthode de propagation des ondes

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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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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 6721-8:1997), which has been technically revised. The main changes compared to the previous edition are as follows:

— the document has been revised editorially;

— normative references have been changed to undated.

A list of all parts in the ISO 6721 series can be found on the ISO website.

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.

Plastics — Determination of dynamic mechanical properties —

Part 8: Longitudinal and shear vibration — Wave-propagation method

1 Scope

This document describes an ultrasonic wave propagation method for determining the storage components of the longitudinal complex modulus L^* and the shear complex modulus G^* of polymers at discrete frequencies typically in the range 0,5 MHz to 5 MHz. The method is suitable for measuring materials with storage moduli in the range 0,01 GPa to 200 GPa and with loss factors below 0,1 at around 1 MHz. With materials that have a higher loss, significant errors in velocity measurement are introduced through waveform distortion and can only be reduced using procedures that are outside the scope of this document.

The method allows measurements to be made on small specimens, typically 50 mm × 20 mm × 5 mm, or small regions of larger specimens or sheets. It is therefore possible to obtain information on the homogeneity or anisotropy (see 10.5) of modulus in a specimen.

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 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 1183-3, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pyknometer method*

ISO 6721-1, *Plastics — Determination of dynamic mechanical properties — Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6721-1 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
longitudinal modulus
ratio of an uniaxial tensile or compressive stress applied to a specimen to the resulting uniaxial strain when the strain in a plane transverse to the axis of applied stress is zero

Note 1 to entry: See ISO 6721-1 for relationships between this and other moduli.

3.2
longitudinal acoustic wave
sound wave in which the particle displacement is in the direction of wave propagation

3.3
transverse acoustic wave
sound wave in which the particle displacement is perpendicular to the direction of wave propagation

3.4
bulk wave
mode of propagation of an acoustic wave in a material whose boundaries normal to the direction of propagation are infinitely remote

Note 1 to entry: This mode is realized in practice for waves whose wavelength is much less than the dimensions of the specimen transverse to the direction of propagation.

Note 2 to entry: In practice, the acoustic wave frequency is then ultrasonic.

4 Principle

Measurements are made of the velocity of longitudinal and transverse acoustic waves in a specimen and the specimen density. The frequency of the wave is chosen so that its wavelength in the specimen is significantly less than the specimen dimensions in a plane transverse to the direction of wave propagation. The wave then propagates as a bulk wave. The longitudinal and shear storage moduli are given by the product of the material density and the square of the longitudinal and the shear wave velocities respectively.

Two methods are described in this document for measuring wave velocities. In the immersion method, the specimen intercepts a beam of longitudinal acoustic wave pulses passing between a transmitting and receiving transducer in a bath of a suitable liquid. At normal incidence, longitudinal wave pulses are excited in the specimen. As the angle of incidence is increased, the amplitude of the longitudinal refracted wave decreases and a refracted transverse (shear) wave is generated. Longitudinal and transverse wave velocities are deduced from measurements of differences in pulse transit times with and without the specimen in the beam and a knowledge of the velocity of sound in the liquid.

In the transducer contact method, the specimen is sandwiched between two transducers, one launching and the other receiving acoustic wave pulses. For the determination of longitudinal and transverse wave velocities, transducer pairs having longitudinal and transverse polarisations, respectively, are used. Wave velocities are again obtained from measurements of differences in pulse transit times with and without the specimen in the beam.

5 Testing device

5.1 Apparatus

The requirements of the apparatus are that it shall enable measurement of the velocities of longitudinal and transverse ultrasonic waves in a specimen. Two methods are described in this document.