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Plastics — Determination of dynamic mechanical properties —

Part 6:
Shear vibration — Non-resonance method

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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 6721-6:1996), which has been technically revised. It also incorporates the Amendment ISO 6721-6:1996/Amd.1:2007. 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 6:
Shear vibration — Non-resonance method

1 Scope

This document describes a forced, non-resonance method for determining the components of the shear complex modulus G^* of polymers at frequencies typically in the range 0,01 Hz to 100 Hz. Higher-frequency measurements can be made, but significant errors in the dynamic properties measured are likely to result (see 10.2.2 and 10.2.3). The method is suitable for measuring dynamic storage moduli in the range 0,1 MPa to 50 MPa.

NOTE Although materials with moduli greater than 50 MPa can be studied, more accurate measurements of their dynamic shear properties can be made using a torsional mode of deformation (see ISO 6721-2 and ISO 6721-7).

This method is particularly suited to the measurement of loss factors greater than 0,02 and can therefore be conveniently used to study the variation of dynamic properties with temperature and frequency through most of the glass-rubber relaxation region (see ISO 6721-1). The availability of data determined over wide ranges of both frequency and temperature enables master plots to be derived, using frequency/temperature shift procedures, which display dynamic properties over an extended frequency range at different temperatures.

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 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 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/

4 Principle

A test-specimen assembly is subjected to a sinusoidal shear force or deformation at a frequency significantly below the fundamental shear resonance frequency (see 10.2.2). The amplitudes of the force and displacement cycles applied to the test-specimen assembly and the phase angle between these cycles are measured. The storage and loss components of the shear complex modulus and the loss factor are calculated using formulae given in Clause 10.

5 Apparatus

5.1 Loading assembly

5.1.1 General

The requirements for the loading assembly are that it shall permit measurements of the amplitudes of, and phase angle between, the force and displacement cycles for a test specimen assembly subjected to a sinusoidal shear force or deformation. Various designs of apparatus are possible: a suitable version is shown schematically in Figure 1. The shear test-specimen assembly consists of two identical specimens S of the polymer bonded to or clamped between metal end-pieces P_1 and P_2. A sinusoidal force is generated by the vibrator V and applied to the two outer end-pieces P_1 of the test-specimen assembly through the clamping device C_1 of the shear load stage. The amplitude and frequency of the vibrator table displacement are variable and monitored by the transducer D. The test-specimen assembly is held at its centre P_2 by a fixed clamp C_2, and thus each specimen S of the polymer is subjected to simple shear deformations of equal magnitude. The sinusoidal force applied in deforming the test-specimen assembly is monitored by a force transducer F connected to C_2.

Alternatively, the force can also be calculated from the current supplied to the vibrator.

The members between the clamps C_1 and V, and between C_2 and F, shall be much stiffer than the test-specimen assembly and shall have a low thermal conductance if the test-specimen assembly is to be enclosed in a temperature-controlled cabinet.

While each member of the loading assembly may have a much higher stiffness than the test-specimen assembly, the presence of clamped or bolted connections can significantly increase the apparatus compliance. It may then be necessary to apply a compliance correction as described in 10.2.4.

A clamping arrangement may be used in which a single specimen of the polymer is subjected to a simple shear deformation, but precautions shall then be taken to ensure that any torque in the loading assembly resulting from the application of load to the specimen does not influence the measurements of the dynamic shear force and displacement. Measurements of the deformation of the specimen may also be made by locating the displacement transducer so as to measure the relative displacement of the two parts C_1 and C_2 of the load stage. The magnitude of the correction for the compliance of the loading assembly will then become small or negligible (see 10.2.4).

5.1.2 Load stage

The shear load stage shall be capable of gripping the test-specimen assembly with sufficient force to prevent any relative movement between the metal blocks P of the test-specimen assembly and the load stage clamps, and to maintain the force at low temperatures. Any misalignment of the load stage with respect to the force transducer will produce a lateral component of the force applied to the transducer during loading of the test-specimen assembly. The alignment of the loading assembly and test-specimen assembly shall be such that any lateral component recorded by the transducer is less than 1 % of the applied longitudinal force.

5.1.3 Transducers

The term transducer in this document refers to any device capable of measuring the applied force or displacement, or the ratio of these quantities, as a function of time. The calibration of the transducers shall be traceable to national standards for the measurement of force and length. The calibration shall be accurate to ± 2 % of the minimum force and displacement cycle amplitudes applied to the test-specimen assembly for the purpose of determining dynamic properties.