INTERNATIONAL STANDARD

ISO 6721-7

Second edition
2019-04

Plastics — Determination of dynamic mechanical properties —

Part 7: Torsional vibration — Non-resonance method

Plastiques — Détermination des propriétés mécaniques dynamiques —

Partie 7: Vibration en torsion — Méthode hors résonance

Reference number
ISO 6721-7:2019(E)

Contents

Page

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 6721-7:1996), which has been technically revised. It also incorporates the Amendment ISO 6721-7:1996/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 7:
Torsional vibration — Non-resonance method

1 Scope

This document describes a torsional, non-resonance method for determining the components of the shear complex modulus G^* of solid polymers in the form of bars or rods at frequencies typically in the range 0,001 Hz to 100 Hz. Higher-frequency measurements can be made, but significant errors in the dynamic properties measured are likely to result (see 10.2.1 and 10.2.2). The method is suitable for measuring dynamic storage moduli ranging from about 10 MPa, which is typical of values obtained for stiff rubbers, to values of about 10 GPa which are representative of fibre-reinforced plastics. Although materials with moduli less than 10 MPa can be studied, more accurate measurements of their dynamic properties can be made using simple shear (see ISO 6721-6) or torsional deformations of thin layers between parallel plates.

This method is particularly suited to the measurement of loss factors greater than 0,02 and may 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 enable master plots to be derived, using frequency-temperature shift procedures, which display dynamic properties over an extended frequency range at different temperatures.

NOTE Although loss factors below 0,1 can be more accurately determined using the torsion pendulum (see ISO 6721-2), the method described in this document enables a much wider and continuous frequency range to be covered.

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

The specimen is subjected to a sinusoidal torque or angular displacement at a frequency significantly below the fundamental torsion resonance frequency (see 10.2.1). The amplitudes of the torque and displacement cycles applied to the specimen 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 Test device

5.1 Loading assembly

5.1.1 General

The requirements on the apparatus are that it shall permit measurements of the amplitudes of, and phase angle between, the torque and angular displacement cycles for a specimen subjected to a sinusoidal torque or displacement. Various designs of apparatus are possible, as illustrated schematically in Figures 1 a) and 1 b). In Figure 1 a), a sinusoidal angular displacement is generated by the drive unit D and applied to one end of the specimen S through the moving clamp C_1. The amplitude and frequency of the angular displacement are variable and monitored by the rotary displacement transducer R. The specimen is held at the opposite end by a fixed clamp C_2 and thus undergoes sinusoidal torsional deformations. The sinusoidal torque applied in deforming the specimen is monitored by a torque transducer T connected to C_2. The members between the clamp C_1 and D and between C_2 and T should be much stiffer than the specimen and should have a low thermal conductance if the specimen is to be enclosed in a temperature-controlled cabinet. Where tests are carried out at elevated temperatures, a facility shall be included in the loading assembly to avoid buckling of the specimen resulting from thermal expansion.

While each member of the loading assembly may have a much higher stiffness than the specimen, 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 10.2.3.

Various other loading assemblies may be employed as alternatives to that detailed above. For example, the torque on the specimen may be calculated from the current supplied to the drive unit, thus eliminating the need for a separate torque transducer. With this method [Figure 1 b)], it should be recognized that part of the torque generated by the drive current is used to accelerate the drive shaft and also to deform any drive shaft suspension (Su) in parallel with the specimen. That part of the generated torque used to deform the specimen shall be determined with the aid of a separate calibration with the specimen absent. Alternatively, the suspension member may be replaced by an air bearing, thereby making the torsional rigidity of the suspension zero.

5.1.2 Clamps

The clamps shall be capable of gripping the test specimen with a force which is sufficient to prevent the specimen from slipping during the torsional deformation and maintaining the force at low temperatures.

The separation between the two clamps should preferably be variable so that specimens of different length can be accommodated and length corrections may be determined (see 10.2.4). A facility to permit small variations in the clamp separation would also allow for thermal expansion of the specimens and is necessary to avoid errors in the apparent moduli due to buckling of the specimens at high temperatures.

Any misalignment of the clamps with respect to the force transducer will produce a lateral component of the torque applied to the transducer during loading of the specimen. The alignment of the loading assembly and test specimen shall be such that any lateral component recorded by the transducer is less than 1 % of the applied torque.

5.1.3 Transducers

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

