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Plastics — Determination of dynamic mechanical properties —

Part 3:
Flexural vibration — Resonance-curve method

Plastiques — Détermination des propriétés mécaniques dynamiques —

Partie 3: Vibration en flexion — Méthode en résonance

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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,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 6721-3:1994), which has been technically revised. It also incorporates the Technical Corrigendum ISO 6721-3:1994/Cor 1:1995.

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

— the document has been revised editorially;

— the normative references have been updated;

— the NOTE in Clause 3 has been moved to Clause 4;

— the method of specimen density measurement has been defined.

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 3: Flexural vibration — Resonance-curve method

1 Scope

This document specifies a bending-vibration method based upon resonance curves for determining the flexural complex modulus E_f^* of homogeneous plastics and the damping properties of laminated plastics intended for acoustic insulation, for example systems consisting of a metal sheet coated with a damping plastic layer, or sandwich systems consisting of two sheet-metal layers with an intermediate plastic layer. For many purposes, it is useful to determine these properties as a function of temperature and frequency.

2 Normative reference

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 pycnometer 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 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 specimen is submitted to forced bending vibrations in the frequency range between about 10 Hz and 1 000 Hz. The resonance curve (see ISO 6721-1) is determined and, from the curve obtained, the flexural storage modulus E'_f is calculated in the range above 0,5 MPa and the loss factor given by $\tan \delta = E''_f / E'_f$ is calculated in the range between about 10^{-2} and 10^{-1} (see NOTE). The test frequency can be varied by making measurements at more than one vibrational order. The measurement range for the flexural loss modulus E''_f is determined by that of the loss factor and by the value of the storage modulus.

The mode of oscillation used is designated oscillation mode III (see ISO 6721-1) and the type of modulus measured is designated E_f.

The test is performed on rectangular bars, either mounted vertically with the upper end clamped and the other end free (method A) or suspended horizontally by fine fibres at vibrational nodes (method B) (see Figure 1). Method A is suitable for testing specimens of most types of plastic, including relatively soft materials, whereas method B is particularly suitable for testing rigid (i.e. dimensionally stable) specimens, for example sheet metal covered by a plastic layer for damping purposes.

NOTE As stated in ISO 6721-1, frequencies derived from resonance curves based on deformation-rate amplitude measurements are exactly related to dynamic properties. For the recommended range of the loss factor of this document, i.e. tan $\delta < 0,1$, resonance curves based upon deformation amplitudes are also related to dynamic properties of the material.

5 Test apparatus

5.1 General

The apparatus consists of devices for clamping (method A) or suspending (method B) the specimen, electronic devices (frequency generator and recording device) for exciting the specimen to forced bending vibration, and for measuring the frequency as well as the velocity amplitude of the specimen. For excitation and detection of the vibrations two electromagnetic transducers are situated near the ends of the specimen. The specimen, the clamping or supporting device and the electromagnetic transducers are enclosed in a temperature-controlled chamber (see Figure 1).

5.2 Clamps or suspension fibres

If the specimen is clamped at one end, the clamp shall be designed to hold the upper end of the specimen securely and tightly [see Figure 1 a)]. It shall be constructed so that no additional damping of the system occurs.

There are two causes of additional damping.

— Friction between the test specimen and the clamp: This can be detected by stimulating freely decaying oscillations of the relevant vibrational order. As explained in ISO 6721-1, the type of decay is indicative of different types of deviation from linear viscoelastic behaviour.

— Vibration of the clamp: The clamp shall be rigidly mounted on a heavy mass, which acts as a counterweight to the oscillating test specimen. This requires a heavy rigid stand within the temperature-controlled chamber (see Figure 1).

If the specimen is tested in the horizontal position, it shall be supported by two fine fibres at vibrational nodes (see 9.4.2).

5.3 Exciter and detector

The frequency generator shall be capable of exciting the specimen with the aid of the electromagnetic transducer to oscillations within the frequency range of 10 Hz to 1 000 Hz with a constant force amplitude.

The detector shall be capable of measuring the deformation or deformation-rate amplitude (see NOTE in Clause 4) of the specimen and the frequency of the oscillation, thereby permitting the recording of the resonance curve.

The amplitude of the exciter and the sensitivity of the detector shall not vary with frequency by more than 0,5 % within the range of a single-resonance peak, i.e. for any 10 % variation of the frequency.

A tracking filter shall be used to minimize noise at the detector. Frequencies shall be measured with a resolution of at least 0,1 % (see 11.2).

