
**Plastics — Determination of dynamic
mechanical properties —**

**Part 11:
Glass transition temperature**

*Plastiques — Détermination des propriétés mécaniques
dynamiques —*

Partie 11: Température de transition vitreuse





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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 on 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 the following URL: 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 6721-11:2012), which has been technically revised. The main changes compared to the previous edition are as follows:

- the scope has been revised to specify suitable materials more accurately;
- definitions of specific points in DMA curves have been extended;
- reference to quality assurance purposes have been deleted;
- several methods have been introduced for evaluation of the glass transition temperature;
- the procedure for determination of heat dependent results has been revised;
- curves of storage modulus, loss modulus and loss factor have been added to the test report;
- the temperature calibration procedure has been revised;
- additional temperature reference specimen for different loading modes has been introduced.

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 <https://www.iso.org/members.html>.

Introduction

This document covers the use of dynamic mechanical analysis (DMA) procedures, in the temperature scanning mode, to determine a value for the glass transition temperature of plastics. It provides an alternative procedure to the use of differential scanning calorimetry (DSC) (see ISO 11357-2)^[1] for this measurement.

DMA is used to determine the variation of the storage modulus, loss modulus and loss factor as a function of temperature and frequency. From these data, a value for the glass transition temperature is determined. Many types of commercial equipment are available that use this technique, and, in principle, it applies to all the loading modes described in ISO 6721-1.

The procedures minimize errors due to thermal lag of the specimen, which varies with the heating rate used, through assuming the specimen temperature is given by the measured oven temperature^[2]. This eliminates the need for the temperature of the specimen to be measured directly by, for example, a thermocouple embedded in the specimen.

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WARNING — The use of this document may involve hazardous materials, operations and equipment. The document does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to determine the applicability of any other restrictions prior to its use.

1 Scope

This document specifies methods for determining a value of the glass transition temperature (T_g) from the dynamic mechanical properties measured during a linear temperature scan under heating conditions. The glass transition temperature is an indicator of the transition from a hard and relatively brittle glassy state to a rubbery or viscous liquid state in an amorphous polymer or in amorphous regions of a partially crystalline polymer.

Usually referred to as dynamic mechanical analysis (DMA), the methods and their associated procedures can be applied to unreinforced and filled polymers, foams, rubbers, adhesives and fibre-reinforced plastics/composites. The methods are limited to materials that are inherently stable above T_g , i.e. amorphous materials that transform into a rubbery state or partially crystalline materials that keep their shape due to crystallinity.

Different modes (e.g. flexure, torsion, shear, compression, tension) of dynamic mechanical analysis can be applied, as appropriate, to the form of the source material.

Measured T_g values using instrumentation can vary as a result of material characteristics and/or the test set-up. The temperature sensor in a DMA instrument is not in contact with the test specimen and therefore measures temperature of the environment surrounding the specimen under test. The resulting data can vary with the heating rate applied. A procedure is included to take into account the thermal lag influencing the measured data.

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 472, *Plastics — Vocabulary*

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 472, 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>