

Electrical insulating materials — Methods of test for the determination of the glass transition temperature

The European Standard EN 61006:2004 has the status of a British Standard

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National foreword

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The UK participation in its preparation was entrusted by Technical Committee GEL/15, Insulating material, to Subcommittee GEL/15/5, Methods of test, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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English version

**Electrical insulating materials –
Methods of test for the determination
of the glass transition temperature
(IEC 61006:2004)**

Matériaux isolants électriques –
Méthodes d'essai pour la détermination
de la température de transition vitreuse
(CEI 61006:2004)

Elektroisolierstoffe –
Prüfverfahren zur Bestimmung
der Glasübergangstemperatur
(IEC 61006:2004)

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European Committee for Electrotechnical Standardization
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Foreword

The text of document 15E/222/FDIS, future edition 2 of IEC 61006, prepared by SC 15E, Methods of test, of IEC TC 15, Insulating materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61006 on 2004-03-01.

This European Standard supersedes EN 61006:1993

Changes from EN 61006:1993 are as follows:

- the standard has been completely revised from an editorial point of view and adapted to the state of the art;
- a figure to demonstrate the dynamic mechanical analysis has been introduced.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2004-12-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2007-03-01 |

Endorsement notice

The text of the International Standard IEC 61006:2004 was approved by CENELEC as a European Standard without any modification.

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ELECTRICAL INSULATING MATERIALS – METHODS OF TEST FOR THE DETERMINATION OF THE GLASS TRANSITION TEMPERATURE

1 Scope

This International Standard specifies procedures for test methods for the determination of the glass transition temperature of solid electrical insulating materials. They are applicable to amorphous materials or to partially crystalline materials containing amorphous regions which are stable and do not undergo decomposition or sublimation in the glass transition region.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1

glass transition

physical change in an amorphous material or in amorphous regions of a partially crystalline material from (or to) a viscous or rubbery condition to (or from) a hard one

NOTE The glass transition generally occurs over a relatively narrow temperature region and is similar to the solidification of a liquid to a glass state; it is not a first order transition. Not only do hardness and brittleness undergo rapid changes in this temperature region, but other properties such as thermal expansion and heat capacity also change rapidly. This phenomenon is also referred to as a second order transition, rubber transition or rubbery transition. Where more than one amorphous transition occurs in a material, the one associated with changes in the segmental motions of the molecular backbone or accompanied by the largest change in properties is usually considered to be the glass transition. Blends of amorphous materials may have more than one glass transition, each associated with a separate component of the blend.

2.2

glass transition temperature

T_g

midpoint of a temperature range over which the glass transition takes place

NOTE 1 The glass transition temperature can be determined readily only by observing the temperature range in which a significant change takes place in some specific electrical, mechanical, thermal, or other physical property. Moreover, the observed temperature can vary significantly depending on the property chosen for observation and on details of the experimental technique (e.g., heating rate, frequency of test). Therefore, the observed T_g should be considered only an approximate value, valid only for that particular technique and test conditions.

NOTE 2 For the purpose of test method C (see Clause 7), the temperature of the peak of the mechanical dissipation factor curve accompanying the glass transition is taken to be the glass transition temperature.

2.3

differential scanning calorimetry

DSC

technique in which the difference in heat flow energy inputs into a tested material and a reference material is measured as a function of temperature while the tested material and the reference material are subjected to a controlled temperature programme

NOTE The record is the differential scanning calorimetric or DSC curve.

2.4

differential thermal analysis

DTA

technique in which the temperature difference between a tested material and a reference material is measured as a function of temperature while the common environment of the tested material and the reference material is subjected to a controlled temperature programme

NOTE 1 The record is the differential thermal analysis or DTA curve.

NOTE 2 There are four characteristic transition points associated with a glass transition (see Figure 1).

- Extrapolated onset temperature (T_i) in °C – The point of intersection of the tangent drawn at the point of greatest slope on the transition curve with the extrapolated baseline prior to the transition.
- Extrapolated endset temperature (T_e) in °C – The point of intersection of the tangent drawn at the point of greatest slope on the transition curve with the extrapolated baseline following the transition.
- Midpoint temperature (T_m) in °C – The point on the thermal curve corresponding to half the heat flow difference between the extrapolated onset and extrapolated endset.
- Inflection temperature (T_i) in °C – The point on the thermal curve corresponding to the peak of the first derivative (with respect to temperature) of the parent thermal curve. This point corresponds to the inflection point of the parent thermal curve.

Two additional transition points are sometimes identified and are defined.

- Temperature of first deviation (T_o) in °C – The point of first detectable deviation from the extrapolated baseline prior to the transition.
- Temperature of return-to-baseline (T_r) in °C – The point of last deviation from the extrapolated baseline beyond transition.

For the purpose of this standard T_m will be taken as the glass transition temperature T_g which usually corresponds more closely to the transition determined by the dilatometric and other methods.

NOTE 3 Other temperatures than those previously defined can be used for specification purposes as established by individual contract.

2.5

thermodilatometry

technique in which a dimension of a test specimen under negligible load is measured as a function of temperature whilst the substance is subjected to a controlled temperature programme

2.6

thermomechanical analysis

TMA

technique in which a deformation of a test specimen under non-oscillatory load is measured as a function of temperature whilst the test specimen is subjected to a controlled temperature programme

2.7

dynamic mechanical analysis

DMA

technique in which either the storage elastic or loss modulus, or both, of a substance under oscillatory load or deformation is measured as a function of temperature, frequency or time, or combination thereof

2.8

complex storage modulus

complex quantity equal to the ratio of mechanical stress to mechanical strain under sinusoidal conditions