ISO/IEC TC 61/SC 11 WD to NWIP 673

Date: 2003-07-24

ISO-IEC_

ISO/IEC TC 61/SC 11/WG 5

Secretariat: JISC

Introductory element Adhesives — Main element A standard database of properties for structural adhesives — Complementary element

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Document type:
Document subtype:
Document stage:
Document language: E

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Foreword

Introduction

Over recent years there has been an increase in the use of computer methods for the selection and evaluation of adhesives and for the manufacture and design of joints with these materials. The data sheets from materials suppliers generally do not supply all the property data that are needed to support the selection and use of adhesives by these methods.

This International Standard specifies a set of basic properties for adhesives commonly required for the use of these materials in a wide range of applications. Test methods and test conditions are recommended for the measurement of the data to enable traceability of presented values.

In selecting the contents for this database, attempts have been made to find a balance in the quantity of data specified. Too much and data suppliers will be reluctant to produce the data, too little and the database has limited value. The aim is therefore not to present a comprehensive list of properties for adhesives but to be selective in identifying the most important properties that are needed for the use of adhesives for different applications. It should be noted that many adhesives have been developed with special properties for a particular application. It is possible that these properties will not be specified in the list associated with this Standard. However, scope has been included within this Standard for the presentation of additional data under test conditions identified by the data supplier. In this way the special properties of the adhesive can be presented with the basic data.

Introductory element Adhesives — Main element A standard database of properties for structural adhesives — Complementary element

1 Scope

The Standard specifies a set of basic properties commonly required for the selection, manufacture and use of structural adhesives in different applications. ISO standard test methods and test conditions are also recommended for the measurement of these data to facilitate traceability of recorded values.

2 Normative references

The following referenced documents are indispensable for the application 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 62 Plastics – Determination of water absorption.

ISO 179-1 Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test.

ISO 179-2 Plastics – Determination of Charpy impact properties – Part 2: Instrumented impact test.

ISO 527-1 Plastics – Determination of tensile properties – Part 1: General principles.

ISO 527-2 Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics.

ISO 1183 Plastics – Methods for determining the density and relative density of non-cellular plastics.

ISO 1817 Rubber, vulcanised – Determination of the effect of liquids.

ISO 2555 Plastics – Resins in the liquid state or as emulsions or dispersions – Determination of apparent viscosity by the Brookfield Test method.

ISO 3219 Plastics – Polymers/resins in the liquid state or as emulsions or dispersions – Determination of viscosity using a rotational viscometer with defined shear rate.

ISO 4587 Adhesives – Determination of tensile lap-shear strength of rigid-to-rigid bonded assemblies.

ISO 4588 Adhesives – Guidelines for the surface preparation of metals.

ISO 6721-4 Plastics – Determination of dynamic mechanical properties – Part 4: Tensile vibration – Non-resonance method.

ISO 6721-5 Plastics – Determination of dynamic mechanical properties – Part 5: Flexural vibration – Non-resonance method.

ISO 9142 Adhesives – Guide to the selection of standard laboratory ageing conditions for testing bonded joints.

ISO 9653 Adhesives – Test method for shear impact strength of adhesive bonds.

ISO 10364 Adhesives – Determination of working life (pot life) of multi-component adhesives.

ISO 11003-2 Adhesives – Determination of shear behaviour of structural adhesives – Part 2: Tensile test method using thick adherends.

ISO 11357-2 Plastics – Differential scanning calorimetry (DSC) – Part 2: Determination of glass transition temperature.

ISO 11359-2 Plastics – Thermomechanical analysis (TMA) – Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature.

ISO 13445 Adhesives – Determination of shear strength of adhesive bonds between rigid substrates by the block-shear method.

ISO 13895 Adhesives – Guidelines for the surface preparation of plastics.

ISO 15166-1 Adhesives – Methods of preparing bulk specimens – Part 1: Two-part systems.

ISO 15166-2 Adhesives – Methods of preparing bulk specimens – Part 2: Elevated-temperature-curing one-part systems.

IEC 60093 Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials.

IEC 60243-1 Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies.

3 Principle

A list is presented of properties that are generally useful for the selection and application of structural adhesives. Recommended test methods and test conditions are specified for each property to guide the determination of values and to promote the presentation of traceable and comparable data.

4 Test specimens

Where possible, use the test specimens recommended in the test method standards employed to measure the properties recorded in tables 1, 2 and 3. If alternative test methods are used, the test reference shall be recorded with the data.

5 Test conditions

Where possible, use the test conditions specified with each property in tables 1, 2 and 3. If alternative test conditions are used, these shall be recorded with the data.

6 Test procedures

6.1 Basic properties

Test methods and test conditions recommended for the acquisition of data for basic properties are given in table 1. The measurement temperature is 23 °C. For measurements obtained at other temperatures, record the temperature with the value.

Table 1 — Basic properties at 23 °C

Record cure temperature, cure time, post-cure temperature and post-cure time used for specimen preparation.			
Property	**Units**	**Test method**	**Additional information**
Tensile modulus	GPa	ISO 527-2	Use bulk specimens (see Note 1)
Stress at failure	MPa		See Note 2
Strain at failure	%		
Yield stress	MPa		See Note 3
Yield strain	%		
Lap shear strength	MPa	ISO 4587	Record thickness of adhesive layer. Record adherend material and surface treatment (see ISO 4588 or 13895).
T-peel strength			Record adherend material and surface treatment (see ISO 4588 or 13895).
Toughness	kJ/m^2	See Note 4	
Impact resistance		ISO 9653 or ISO 13445	
Hardness			
Glass transition temperature	°C	ISO 11357-2 or ISO 11359-2	The measured value from these tests will not generally be the same.
DMTA curve	GPa	ISO 6721-4	From –40 to above T_g.
Service temperature range		See Note 5	
Viscosity	Pa.s	ISO 2555 or ISO 3219	Record shear strain rate and time under load if the adhesive is thixotropic.
Working life	minutes	ISO 10364	
Density	kg/m^3	ISO 1183	
Water absorption	%	ISO 62	Saturation value at 23 °C.

Volume resistivity	ohm.m	IEC 60093	
Electric strength	kV/mm	IEC 60243	

Note 1 See ISO 15166 parts 1 and 2 for procedures on bulk specimen preparation.

Note 2 Strain at failure for ductile materials is measured after yield and therefore requires the measurement of a nominal strain. The nominal strain is derived from measurements of grip separation instead of extensometer values. See ISO 527-1 clauses 4.10 and 9.5 for the definition and measurement of nominal strain.

Note 3 See ISO 527-1 clauses 4.8 and 4.9 for details on the measurement of stress and strain at yield.

Note 4 The main interest in the toughness of an adhesive involves a knowledge of the temperature of the transition from ductile to brittle behaviour. Indications of this temperature can be obtained from tests that measure ductility as a function of temperature. Suitable tests involve measurements of the strain at failure in tensile tests (see ISO 527) and fracture energy in impact tests on bulk or joint specimens (see ISO 179 and ISO 9653 or ISO 13445, respectively).

Note 5 The service temperature range will be determined by the criteria used to decide maximum and minimum operating temperatures. Generally, the upper temperature is decided by the glass transition temperature T_g and the lower temperature by the transition from ductile to brittle behaviour. This lower temperature limit can be determined from measurements of toughness or ductility with temperature (see Note 4).

6.2 Durability in different environments

Data measured using the test method and conditions listed in table 2 reveal the influence on the lap shear strength of the adhesive of exposure to different environments. Results obtained using the conditions specified in the first row show the dependence of shear strength on temperature separately from the effects of any ageing. In subsequent rows, specimens are subjected to exposure for 30 days in the environments shown and then tested at 23 ^{o}C. See ISO 9142 for the procedure for conditioning specimens. Where it is known that a particular adhesive is not recommended for use with the chemicals shown in table 2, then the letters NR shall be given in place of experimental values.

Table 2 — Durability data in different environments

<table>
<tr><td colspan="4">Record cure temperature, cure time, post-cure temperature and post-cure time used for specimen preparation.

Record adherend material and surface treatment (see ISO 4588 or 13895).</td></tr>
<tr><th>Property</th><th>Test condition</th><th colspan="2">Specimen conditioning-ageing prior to test</th></tr>
<tr><td>Lap-shear strength

ISO 4587</td><td>-40 °C, 23 °C and 70 °C</td><td colspan="2">Values are prior to ageing. Include optional additional temperatures to demonstrate the working range of the adhesive.</td></tr>
<tr><td rowspan="11"></td><td rowspan="11">23 °C</td><td rowspan="11">Expose for 30 days</td><td>At 70 °C</td></tr>
<tr><td>90% RH at 70 °C</td></tr>
<tr><td>Water at 23 °C</td></tr>
<tr><td>Water at 90 °C</td></tr>
<tr><td>Isopropyl alcohol at 23 °C</td></tr>
<tr><td>10% acetic acid at 23 °C</td></tr>
<tr><td>35% sodium hydroxide at 23 °C</td></tr>
<tr><td>Standard fuel (ISO 1817 liquid 2) at 23 °C</td></tr>
<tr><td>Motor oil (ISO 1817 oil No.3) at 23 °C</td></tr>
<tr><td>Ethylene glycol 50% by volume in water at 23 °C</td></tr>
<tr><td>Optional other chemicals and temperatures. Record details.</td></tr>
</table>

6.3 A simple stress analysis

Data obtained by the tests recorded in Table 3 are required for carrying out calculations of stress and strain distributions in the adhesive in a bonded joint under load, for example using a finite element analysis. If an elastic analysis is carried out, only the first two rows of data are needed. Data specified by the third row are required for an analysis that takes account of plastic deformation described by von Mises yielding.

Table 3 — Properties required for a simple stress analysis

Property	Units	Test method	Additional information
Tensile modulus	GPa	ISO 527-2	See Note 6
Poisson's ratio		ISO 527-2	
Stress vs strain curve	MPa	ISO 527-2	See Note 7

Note 6 In order to characterise elastic behaviour for a stress analysis, values are needed for tensile modulus and Poisson's ratio. These are most conveniently obtained from tests on bulk specimens. If bulk specimens are not available, a value for the shear modulus can be obtained from a thick-adherend shear test, ISO 11003-2, and used with an estimate of Poisson's ratio to calculate a value for the tensile modulus.

Note 7 A stress/strain curve is required to characterise the non-linear behaviour of the adhesive in a stress analysis that takes account of plastic deformation and flow. As with modulus measurements, this is most easily obtained using bulk specimen tests for the determination of tensile properties. Where these are not available, a shear stress/shear strain curve can be determined on joint specimens using the thick-adherend shear test, ISO 11003-2.

7 Precision

For information on the typical precision of the test methods used to generate the data specified in the tables in clause 6, the associated test standard should be consulted.