

CONSOLIDATED VERSION



Printed electronics – Part 201: Materials – Substrates



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.



IEC 62899-201

Edition 1.1 2018-11

CONSOLIDATED VERSION



**Printed electronics –
Part 201: Materials – Substrates**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.035.01; 31.180

ISBN 978-2-8322-6279-5

Warning! Make sure that you obtained this publication from an authorized distributor.

REDLINE VERSION



Printed electronics – Part 201: Materials – Substrates

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	13
4 Materials, structures and dimensions.....	16
4.1 Base materials	16
4.2 Structures of substrates	17
4.3 Dimensions of substrates	17
4.3.1 Outline.....	17
4.3.2 Sheet dimensions	17
4.3.3 Width and length (roll supply)	17
4.3.4 Substrate thickness	18
5 General descriptions of evaluation tests	18
5.1 Sampling.....	18
5.2 Preparation of test specimens.....	18
5.3 Atmospheric conditions for evaluation test	19
5.4 Conditioning.....	19
5.4.1 Polymer substrates	19
5.4.2 Glass substrates.....	19
5.4.3 Other materials.....	19
6 Characteristics and evaluation method of polymer substrates	19
6.1 Surface properties	19
6.1.1 Surface defects	19
6.1.2 Flatness	20
6.1.3 Surface condition.....	21
6.1.4 Edge condition.....	22
6.2 Mechanical properties	23
6.2.1 Elongation at break.....	23
6.2.2 Tensile strength.....	23
6.2.3 Tensile modulus.....	24
6.2.4 Minimum bending radius	24
6.2.5 Tear strength and tear propagation resistance	27
6.2.6 Edge strength	27
6.2.7 Hardness.....	27
6.3 Chemical properties	28
6.3.1 Resistance to chemicals	28
6.3.2 Halide contents.....	28
6.3.3 Volatile content.....	29
6.3.4 Gas transmission.....	29
6.3.5 Moisture absorption	30
6.4 Electrical properties	30
6.4.1 Measurement at ambient temperature.....	30
6.4.2 Measurement at high temperature	32
6.5 Thermal properties.....	33
6.5.1 Glass transition temperature.....	33

6.5.2	Coefficient of linear thermal expansion	33
6.5.3	Dimensional stability	33
6.5.4	Relative temperature index (RTI)	34
6.6	Optical properties	35
6.6.1	Method of testing the colour of the substrates	35
6.6.2	Refractive index	38
6.6.3	Retardation	39
6.6.4	Luminous reflectance	39
6.6.5	Haze	39
6.7	Flammability	40
6.7.1	Outline	40
6.7.2	Test method	40
6.7.3	Report of the results	40
7	Characteristics and evaluation method of glass substrates	40
7.1	Surface properties	40
7.1.1	Surface roughness	40
7.1.2	Chips and cracks	40
7.1.3	Foreign inclusions	41
7.1.4	Foreign substances on surface	41
7.1.5	Scratches	41
7.2	Mechanical properties	42
7.2.1	Young's modulus and Poisson's ratio	42
7.2.2	Density	42
7.2.3	Hardness	42
7.3	Chemical properties	42
7.3.1	Resistance to chemicals	42
7.3.2	Gas transmission	42
7.4	Thermal properties	42
7.4.1	Coefficient of linear thermal expansion	42
7.4.2	Strain point	42
7.5	Optical properties	44
7.5.1	Refractive index	44
7.5.2	Luminous transmittance	44
8	Characteristics and evaluation method of other materials (ceramics, metal, paper, others) paper substrates	44
8.1	General	44
8.2	Surface roughness	45
8.2.1	General	45
8.2.2	Measurement method for class (a)	45
8.2.3	Measurement method for class b)	46
8.2.4	Calculation	46
8.2.5	Report of the results	46
8.3	Defects (pinholes) of coating layer	47
8.3.1	General	47
8.3.2	Test specimens	47
8.3.3	Colour solution	47
8.3.4	Procedure	47
8.3.5	Report of the results	47
8.4	Contact angle	47

8.4.1	General	47
8.4.2	Outline of the measurement method	48
8.4.3	Parameters	48
8.4.4	Test apparatus	48
8.4.5	Test method	49
8.4.6	Report of the results	49
8.5	Surface pH.....	49
8.5.1	General	49
8.5.2	Test specimens	49
8.5.3	Measurement.....	50
8.5.4	Report of the results	50
8.6	Composition of surface (screening of metal composition)	50
8.7	Thickness of coating layer.....	51
8.7.1	General	51
8.7.2	Instrumentation.....	51
8.7.3	Preparation of cross-sections	51
8.7.4	Measurement.....	51
8.7.5	Report of the results	51
9	Storage	51
9.1	Storage conditions	51
9.1.1	Climatic conditions	51
9.1.2	Chemically active substances	52
9.1.3	Mechanically active substances	52
9.1.4	Other conditions	52
9.2	Storage period	52
10	Packaging and marking	52
10.1	Packaging.....	52
10.2	Marking.....	52
10.3	Traceability	52
11	Transportation	52
11.1	Transportation conditions.....	52
11.1.1	Climatic conditions	52
11.1.2	Chemically active substances	52
11.1.3	Mechanically active substances	52
11.1.4	Mechanical condition.....	53
11.1.5	Other conditions	53
11.2	Means of transportation	53
11.3	Vibration resistance	53
11.4	Impact resistance.....	53
	Bibliography.....	54
	Figure 1 – Example of bow.....	14
	Figure 2 – Example of twist.....	14
	Figure 3 – Structure of the flex resistance tester near the part where the specimen is attached.....	25
	Figure 4 – Structure of the MIT instrument	25
	Figure 5 – Example of a measuring electrode	31
	Figure 6 – Parameters related to the contact angle	48

Table 1 – Winding misalignment of the roll.....	17
Table 2 – Test methods for paper and paper board substrates used in PE	44

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRINTED ELECTRONICS –

Part 201: Materials – Substrates

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

DISCLAIMER

This Consolidated version is not an official IEC Standard and has been prepared for user convenience. Only the current versions of the standard and its amendment(s) are to be considered the official documents.

This Consolidated version of IEC 62899-201 bears the edition number 1.1. It consists of the first edition (2016-02) [documents 119/87/FDIS and 119/100A/RVD] and its amendment 1 (2018-11) [documents 119/189/CDV and 119/206A/RVC]. The technical content is identical to the base edition and its amendment.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 62899-201 has been prepared by IEC technical committee 119: Printed electronics.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62899 series, published under the general title *Printed electronics*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The IEC 62899-20x series relates mainly to evaluation methods for materials of printed electronics. The series also includes storage methods, packaging and marking, and transportation conditions.

The IEC 62899-20x series is divided into parts for each material. Each part is prepared as a generic specification containing fundamental information for the area of printed electronics.

The IEC 62899-20x series consists of the following parts:

Part 201: Materials – Substrates

Part 202: Materials – Conductive ink

Part 203: Materials – Semiconductor ink¹

(Subsequent parts will be prepared for other materials.)

Furthermore, sectional specifications, blank detail specifications, and detail specifications for each material will follow these parts.

This part of IEC 62899 is prepared for substrate used in printed electronics and contains the test conditions, the evaluation methods and the storage conditions.

¹ Under consideration.

PRINTED ELECTRONICS –

Part 201: Materials – Substrates

1 Scope

This part of IEC 62899 defines the terms and specifies the evaluation method for substrates used in the printing process to form electronic components/devices. This international standard is also applied to the substrates which make surface treatment in order to improve their performance.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at www.electropedia.org)

IEC 60093:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*

IEC 60216-1:2013, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60216-3, *Electrical insulating materials – Thermal endurance properties – Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Single-chamber ovens*

IEC 60216-5, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*

IEC 60216-6, *Electrical insulating materials – Thermal endurance properties – Part 6: Determination of thermal endurance indices (TI and RTE) of an insulating material using the fixed time frame method*

IEC 60243-1:2013, *Electric strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60674-2:1988, *Specification for plastic films for electrical purposes – Part 2: Methods of test*

IEC 60674-2:1988/AMD1:2001

IEC 60674-3-1:1998, *Plastic films for electrical purposes – Part 3: Specifications for individual materials – Sheet 1: Biaxially oriented polypropylene (PP) films for capacitors*
IEC 60674-3-1/AMD1:2011

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50W horizontal and vertical flame test methods*

IEC 60721-3-1, *Classification of environmental conditions – Part 3 Classification of groups of environmental parameters and their severities – Section 1: Storage*

IEC 60721-3-2, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation*

IEC 61189-2:2006, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 2: Test methods for materials for interconnection structures*

IEC 61189-3:2007, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 3: Test methods for interconnection structures (printed boards)*

IEC 62321-3-1, *Determination of certain substances in electrotechnical products – Part 3-1: Screening – Lead, mercury, cadmium, total chromium and total bromine using X-ray fluorescence spectrometry*

IEC 62899-202-5, *Printed electronics – Part 202-5: Materials – Conductive ink – Mechanical bending test of a printed conductive layer on an insulating substrate*

ISO 5-2, *Photography and graphic technology – Density measurements – Part 2: Geometric conditions for transmittance density*

ISO 5-3, *Photography and graphic technology – Density measurements – Part 3: Spectral conditions*

ISO 62, *Plastics – Determination of water absorption*

ISO 175:2010, *Plastics – Methods of test for the determination of the effects of immersion in liquid chemicals*

ISO 187, *Paper, board and pulps – Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 216, *Writing paper and certain classes of printed matter – Trimmed sizes – A and B series, and indication of machine direction*

ISO 217, *Paper – Untrimmed sizes – Designation and tolerances for primary and supplementary ranges, and indication of machine direction*

ISO 291, *Plastics – Standard atmospheres for conditioning and testing*

ISO 472, *Plastics – Vocabulary*

ISO 489:1999, *Plastics – Determination of refractive index*

ISO 527-1:2012, *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 527-4, *Plastics – Determination of tensile properties – Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

ISO 527-5, *Plastics – Determination of tensile properties – Part 5: Test conditions for unidirectional fibre-reinforced plastic composites*

ISO 534, *Paper and board – Determination of thickness, density and specific volume*

ISO 535, *Paper and board – Determination of water absorptiveness – Cobb method*

ISO 536, *Paper and board – Determination of grammage*

ISO 868, *Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 1924-2, *Paper and board – Determination of tensile properties – Part 2: Constant rate of elongation method (20 mm/min)*

ISO 1924-3, *Paper and board – Determination of tensile properties – Part 3: Constant rate of elongation method (100 mm/min)*

ISO 1974, *Paper – Determination of tearing resistance – Elmendorf method*

ISO 2039-1, *Plastics – Determination of hardness – Part 1: Ball indentation method*

ISO 2039-2, *Plastics – Determination of hardness – Part 2: Rockwell hardness*

ISO 2471, *Paper and board – Determination of opacity (paper backing) – Diffuse reflectance method*

ISO 2493-1, *Paper and board – Determination of bending resistance – Part 1: Constant rate of deflection*

ISO 2493-2, *Paper and board – Determination of bending resistance – Part 2: Taber-type tester*

ISO 2578:1993, *Plastics – Determination of time-temperature limits after prolonged exposure to heat*

ISO 2758, *Paper – Determination of bursting strength*

ISO 2759, *Board – Determination of bursting strength*

ISO 3274, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Nominal characteristics of contact (stylus) instruments*

ISO 3664, *Graphic technology and photography – Viewing conditions*

ISO 3696, *Water for analytical laboratory use – Specification and test methods*

ISO 3781, *Paper and board – Determination of tensile strength after immersion in water*

ISO 3783, *Paper and board – Determination of resistance to picking – Accelerated speed method using the IGT-type tester (electric model)*

ISO 4287, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters*

ISO 4288:1996, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Rules and procedures for the assessment of surface texture*

ISO 5626, *Paper – Determination of folding endurance*

ISO 5635, *Paper – Measurement of dimensional change after immersion in water*

ISO 6383-1, *Plastics – Film and sheeting – Determination of tear resistance – Part 1: Trouser tear method*

ISO 6383-2, *Plastics – Film and sheeting – Determination of tear resistance – Part 2: Elmendorf method*

ISO 6507-1, *Metallic materials – Vickers hardness test – Part 1: Test method*

ISO 6588-1, *Paper, board and pulps – Determination of pH of aqueous extracts – Part 1: Cold extraction*

ISO 6588-2, *Paper, board and pulps – Determination of pH of aqueous extracts – Part 2: Hot extraction*

ISO 7991, *Glass – Determination of coefficient of mean linear thermal expansion*

ISO 8791-2, *Paper and board – Determination of roughness/smoothness (air leak methods) – Part 2: Bendtsen method*

ISO 8791-4, *Paper and board – Determination of roughness/smoothness (air leak methods) – Part 4: Print-surf method*

ISO 9220:1988, *Metallic coatings – Measurement of coating thickness – Scanning electron micro-scope method*

ISO 9773:1998, *Plastics – Determination of burning behaviour of thin flexible vertical specimens in contact with a small-flame ignition source*
ISO 9773:1998/AMD1:2003

ISO 11359-2:1999, *Plastics – Thermomechanical analysis (TMA) – Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

ISO 11556, *Paper and board – Determination of curl using a single vertically suspended test piece*

ISO 11664-4, *Colorimetry – Part 4: CIE 1976 $L^*a^*b^*$ Colour space*

ISO 11798, *Information and documentation – Permanence and durability of writing, printing and copying on paper – Requirements and test methods*

ISO 12192, *Paper and board – Determination of compressive strength – Ring crush method*

ISO 13468-1:1996, *Plastics – Determination of the total luminous transmittance of transparent materials – Part 1: Single beam instrument*

ISO 13468-2:1999, *Plastics – Determination of the total luminous transmittance of transparent materials – Part 2: Double-beam instrument*

ISO 13565-2:1996, *Geometrical Product Specification (GPS) – Surface texture: Profile method; Surfaces having stratified functional properties – Part 2: Height characterization using the linear material ratio curve*

ISO 13655, *Graphic technology – Spectral measurement and colorimetric computation for graphic arts images*

ISO 14782, *Plastics – Determination of haze for transparent materials*

ISO 15105-1, *Plastics – Film and sheeting – Determination of gas-transmission rate – Part 1: Differential-pressure methods*

ISO 15105-2:2003, *Plastics – Film and sheeting – Determination of gas-transmission rate – Part 2: Equal-pressure method*

ISO 15106-1, *Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 1: Humidity detection sensor method*

ISO 15106-2, *Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 2: Infrared detection sensor method*

ISO 15106-3, *Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 3: Electrolytic detection sensor method*

ISO 15106-4, *Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 4: Gas-chromatographic detection sensor method*

ISO 15184, *Paints and varnishes – Determination of film hardness by pencil test*

ISO 15512, *Plastics – Determination of water content*

ISO 15359, *Paper and board – Determination of the static and kinetic coefficients of friction – Horizontal plane method*

ISO 15754, *Paper and board – Determination of z-directional tensile strength*

ISO 15989, *Plastics – Film and sheeting – Measurement of water-contact angle of corona-treated films*

3 Terms and definitions

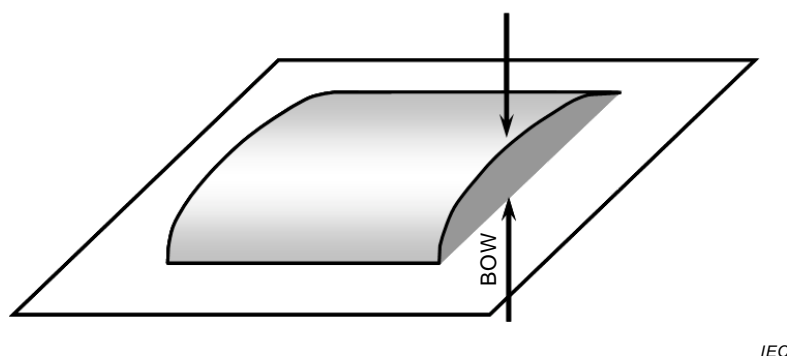
For the purposes of this document, the terms and definitions given in IEC 60050, IEC 60695-11-10, ISO 472, ISO 4287, as well as the following apply.

3.1

bow and twist

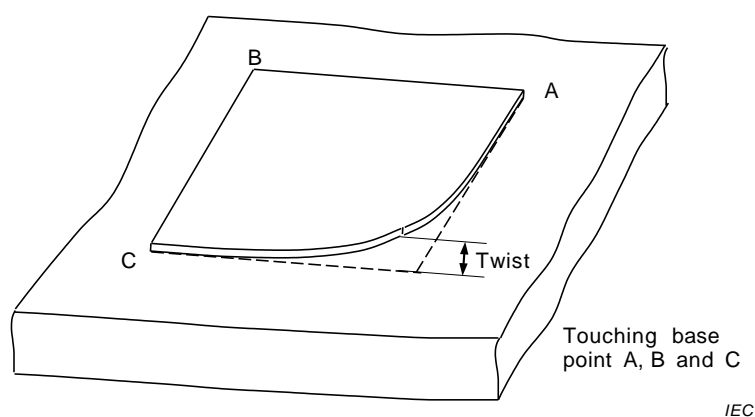
distortion in the dimensions of a plastic object which occurs after moulding or processing

Note 1 to entry: See Figure 1 for an example of bow and Figure 2 for an example of twist.



IEC

Figure 1 – Example of bow



IEC

Figure 2 – Example of twist

3.2 roughness

surface property of a substrate which indicates a high-frequency component of irregular elements in the profile curve

Note 1 to entry: Roughness is obtained as a roughness curve by subtracting noise and micro-waviness (see 3.3) from the profile curve measured with a profile filter and phase compensation filter.

3.3 micro-waviness

surface property of a substrate which indicates a low-frequency component of irregular elements in the profile curve

Note 1 to entry: Micro-waviness is obtained from the average line (from the deviation curve) of the measured profile curve.

3.4 foreign substance on surface

substance which is located on the surface of the substrate and can be removed easily by washing off with water, alcohols, cleaning agents, etc., or ultrasonic cleaning

3.5 foreign inclusion

substance which is completely embedded in the substrate or partially exposed on the surface of the substrate, and cannot be removed by cleaning

3.6

edge condition

state of the edges of the substrate which indicates the presence of distortion, waviness, scratches, fracture, burrs, or foreign substances

3.7

minimum bending radius

smallest limit bending radius for which permanent structural change does not occur

3.8

tear strength

force required to rip test specimens apart

Note 1 to entry: The unit of tear strength is newton (N).

3.9

tear propagation resistance

tear strength (see 3.8) divided by thickness

Note 1 to entry: The unit of tear propagation resistance is newton/millimetre (N/mm).

3.10

gas transmission

ease of gas which passes through a unit area of a substrate per unit time under specified temperature and humidity conditions

3.11

water vapour transmission

amount of water vapour which passes through a unit area of a substrate per unit time under specified temperature and humidity conditions

Note 1 to entry: Water vapour transmission is generally expressed as the mass of water vapour which passes through an area of 1 m^2 in 24 h ($\text{g/m}^2 \cdot \text{d}$).

3.12

oxygen gas transmission

amount of oxygen which passes through a unit area of substrate per unit time and unit partial pressure between both sides of the substrate under specified temperature and humidity conditions

3.13

electric strength

quotient of the maximum voltage applied without breakdown, by the distance between conducting parts under prescribed test conditions

[SOURCE: IEC 60050-212:2010, 212-11-37]

3.14

temperature index

numerical value corresponding to the temperature, in degrees Celsius, derived from the thermal endurance relationship at a given time (normally 20 000 h)

[SOURCE: ISO 2578:1993, 3.1, modified – “numerical value” is used instead of “number”.]

3.15

relative temperature index

temperature index (see 3.14) of a test material, obtained at the time which corresponds to the known temperature index of a reference material when both materials are subjected to the same ageing and diagnostic procedures in a comparative test

[SOURCE: ISO 2578:1993, 3.2, modified – the reference to “temperature index” has been added.]

3.16

chip

<glass substrates> place from which a small piece of glass has been removed from the glass surface

3.17

crack

<glass substrates> lines on the surface of the central or edge of glass where it has broken but not split into separate parts

3.18

scratch

<glass substrates> shallow grooves on a glass surface which are made during handling

Note 1 to entry: A scratch may be accompanied by a crack.

3.19

paper

material without conductivity in the form of a coherent sheet or web, excluding sheets or laps of pulp as commonly understood for paper-making or paper-dissolving purposes and non-woven products, made by deposition of vegetable, mineral, animal or synthetic fibres, or their mixtures, from a fluid suspension onto a suitable forming device, with or without the addition of other substances

Note 1 to entry: There are also a number of synthetic products with paper-like qualities that are applicable as substrates for printed electronics. For the purposes of this document these can be treated as paper for testing as substrates.

[SOURCE: ISO 21067-1:2016, A.1.1, modified – “without conductivity” and NOTE have been added.]

3.20

board

paper (3.19) of a relatively high rigidity

Note 1 to entry: The term “paper” may be used for both paper and board. Materials of grammage less than 225 g/m² are generally considered to be paper, and materials of grammage of 225 g/m² or more to be board.

[SOURCE: ISO 5127:2017, 3.3.5.2.02]

3.21

pinhole

small hole in a printed feature that is a result of a surface inhomogeneity on the substrate

Note 1 to entry: This can be a consequence of a number of causes, and potential examples are listed below:

- a small hole in the surface of the substrate;
- a hole large enough to permit the transfer of an applied functional ink;
- a local variation in the wetting properties of the surface that results in uneven wetting of an applied functional ink.

4 Materials, structures and dimensions

4.1 Base materials

Base materials are used in the printing process to form electronic components/devices that are polymer, glass and other materials such as ceramics, metal, paper, etc.