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INTERNATIONAL STANDARD

colour inside

Printed electronics – Part 201-2: Materials – Substrates – Measurement methods for properties of stretchable substrates

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PRINTED ELECTRONICS –

Part 201-2: Materials – Substrates – Measurement methods for properties of stretchable substrates

FOREWORD

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International Standard IEC 62899-201-2 has been prepared by IEC technical committee 119: Printed Electronics.

This International Standard is to be used in conjunction with IEC 62899-201:2016.

The text of this International Standard is based on the following documents:

Draft	Report on voting
119/369/FDIS	119/375/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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 this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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 measurement 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 201-2: Materials – Substrates – Measurement methods for properties of stretchable substrates

Part 202: Materials – Conductive ink

Part 202-3: Materials – Conductive ink – Measurement of sheet resistance of conductive films – Contactless method

Part 202-4: Materials – Conductive ink – Measurement methods for properties of stretchable printed layers (conductive and insulating)

Part 202-5: Materials – Conductive ink – Mechanical bending test of a printed conductive layer on an insulating substrate

Part 202-6: Materials – Conductive ink – Measurement method for resistance changes under high temperature and humidity – Printed conductive layer on a flexible substrate

Part 202-7: Materials – Printed film – Measurement of peel strength for printed layer on flexible substrate by the 90° peel method

Part 203: Materials – Semiconductor ink

Part 204: Materials – Insulator ink – Measurement methods of properties of insulator inks and printed insulating layers

(Subsequent parts will be prepared for other materials.)

Furthermore, each part will also include sectional specifications, blank detail specifications, and detail specifications of each material.

This part of IEC 62899 does not define the required characteristics of the stretchable substrate. It provides test methods to characterize (pre-qualify) the substrates that are intended to be used for printing conductors and insulators for the purposes of manufacturing stretchable layers or structures.

PRINTED ELECTRONICS –

Part 201-2: Materials – Substrates – Measurement methods for properties of stretchable substrates

1 Scope

This part of IEC 62899 defines measurement methods for the properties of stretchable substrates, in order to use evaluating stretchable functional layers (conductive, semiconducting, and insulating) formed by printing technologies. If the same types of materials as the substrates are used for the cover lay film, they are also subjected to the measurement defined in this document.

Stretchable substrates handled by this document apply to substrates subjected to repeated bending with wiring elements demanding a high level of performance, such as fabric integrated wearable devices or skin patchable devices.

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.

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

IEC 62631-3-1, *Dielectric and resistive properties of solid insulating materials – Part 3-1: Determination of resistive properties (DC methods) – Volume resistance and volume resistivity – General method*

IEC 62631-3-2, *Dielectric and resistive properties of solid insulating materials – Part 3-2: Determination of resistive properties (DC methods) – Surface resistance and surface resistivity*

IEC 62899-201, *Printed electronics – Materials – Part 201: Substrates*

ISO 3801, *Textiles − Woven fabrics – Determination of mass per unit length and mass per unit area*

ISO 5084, *Textiles − Determination of thickness of textiles and textile products*

ISO 13934-1, *Textiles − Tensile properties of fabrics − Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 22198, *Textiles − Fabrics − Determination of width and length*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
stretchable substrate
substrate material (e.g., plastic sheet) that can be mechanically deformed by applying tensile loading (stress) and that exhibits reversible mechanical behaviour (elastic deformation) up to at least 10 % tensile strain

Note 1 to entry: In this document, the stretchable substrates are used to measure the properties of stretchable conductors, semiconducting materials and insulators.

[SOURCE: IEC 62899-101:2019, 3.132, modified – the note has been added.]

3.2
stretchable cover lay film
electrically insulating film made from a stretchable insulator and used as cover layer for stretchable conductors

[SOURCE: IEC 62899-101:2019, 3.130]

3.3
stretchable conductor
electric conductor that exhibits a decrease in conductivity of less than 10 % during mechanical deformation up to at least 10 % tensile strain

[SOURCE: IEC 62899-101:2019, 3.129]

4 Structures and materials

4.1 Structures

Table 1 shows typical structures of the stretchable substrates. They are classified into monolithic structures made of elastic polymers, fabrics with structural stretchability, composite structures (fibre reinforced elastic polymer film or sheet), and elastic resin-coated fabrics.

4.2 Materials

Materials for an elastic polymer film or sheet with monolithic structures include, for example, synthetic rubber, natural rubber, silicone polymers, polyurethanes, and other elastomeric polymers.

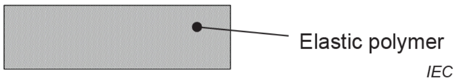
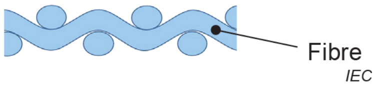
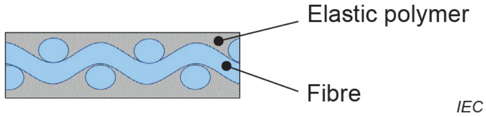
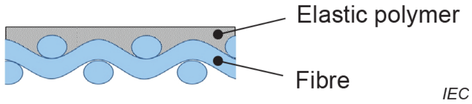
The fibre materials of the fabrics include synthetic fibres such as polyester, polyamide, polyacrylamide, and polyurethane; natural fibres such as cotton and wool; and semi-synthetic fibres such as modified cellulose. The fibres include elastic and non-elastic fibres.

The fabrics include general woven fabrics, general knitted fabrics, and nonwoven fabrics. The fabrics have structural stretchability, but that does not inhibit the use of elastic threads.

These same materials apply to composite structures and elastic resin-coated fabrics.

If the same type of material as the substrate is used for the cover lay film, the stretchable base material of the cover lay may be used together with the adhesive layer.

Table 1 – Types and schematic cross section of stretchable substrates

<table>
<tr><th colspan="2">Types of stretchable substrates</th><th>Cross section</th></tr>
<tr><td colspan="2">Monolithic structure
(elastic polymer film / sheet)</td><td>  </td></tr>
<tr><td rowspan="3">Fabrics</td><td>Woven</td><td rowspan="3">  </td></tr>
<tr><td>Knitted</td></tr>
<tr><td>Nonwoven
(elastic polymer fibre)</td></tr>
<tr><td colspan="2">Composite structure
(fibre reinforced elastic polymer film / sheet)</td><td>  </td></tr>
<tr><td colspan="2">Elastic resin coated fabrics</td><td>  </td></tr>
</table>

5 General description of measurement tests

Preparation and conditioning of the test specimens shall be in accordance with IEC 62899-201. However, except for mechanical tensile tests, the specimens should be kept tension-free under the measurement.

NOTE Substrates whose surface morphology changes significantly due to stretch are not suitable as substrates for measuring the properties of functional material layers.

6 Characteristics and measurement methods of stretchable substrates

6.1 Width and length of stretchable substrates

Width and length of stretchable substrates shall be measured as specified in ISO 22198.

6.2 Thickness of stretchable substrates

Thickness of stretchable substrates shall be measured as specified in ISO 5084.

6.3 Mass per unit area of stretchable fabrics

Mass per unit area (basis weight) is defined as the feature amount of the stretchable fabrics. The mass per unit area of stretchable fabrics shall be measured as specified in ISO 3801.

6.4 Elongation at break of stretchable fabrics

Elongation at break of stretchable fabrics shall be measured as specified in ISO 13934-1. The measurement method is called the strip method. Elongation at break of stretchable coated fabrics, stretchable polymer films and sheets shall be in accordance with IEC 62899-201.

6.5 Volume resistance of stretchable polymer films and sheets

Volume resistance of stretchable polymer films and sheets shall be measured as specified in IEC 62631-3-1. The pressure applied to the substrate under measurement should satisfy the following conditions:

a) It should be 1 kPa or less.