

IEC 62899-202

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# INTERNATIONAL STANDARD



Printed electronics -

Part 202: Materials - Conductive ink

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# - 2 - IEC 62899-202:2023 RLV © IEC 2023

### **CONTENTS**

F	OREWO	RD	4
IN	ITRODU	CTION	2
1	Scop	e	7
2	Norm	ative references	7
3	Term	s and definitions	9
4	Atmo	spheric conditions for evaluation and pre-conditioning	11
5	Sumr	mary characteristics and evaluation method of conductive ink	11
6	Evalı	uation of properties of conductive ink	12
	6.1	Specimen	
	6.2	Contents	
	6.2.1		
	6.2.2	Non-volatile content	13
	6.2.3	Ash content	13
	6.2.4	Foreign matter	14
	6.3	Physical properties	14
	6.3.1	Density	14
	6.3.2	Rheology	15
	6.3.3		
	6.3.4	Size of conductive materials	16
	6.3.5	•	
	6.3.6	•	
	6.3.7		
7	Evalu	uation of the properties of a conductive layer	
	7.1	Test piece	
	7.1.1		
	7.1.2		
	7.1.3		
	7.1.4	·	
	7.1.5	·	
	7.2	Electrical properties	
	7.2.1	•	
	7.2.2		
	7.2.3	Surface resistivity (based on the contactless method)	
	7.3 7.3.1	Bending test	
	7.3.1		
	7.3.2		
	7.4	Optical properties	
	7.4.1	Overview	
	7.4.2		
	7.4.3		
	7.4.4	•	
	7.4.5	-	
	7.4.6		
8		ıge	
	8.1	Storage conditions	

# IEC 62899-202:2023 RLV © IEC 2023 - 3 -

8.2 Method for measuring aged deterioration	31
8.3 Report of the results	31
Annex A (informative) Example of four-point probe for applying an appropriate weight	32
A.1 Internal structure	32
A.2 Example of the general overall view	32
Annex B (informative) Formula of correction factor F	33
B.1 General	
B.2 Conditions for correction factor F	
B.3 Formula of correction factor F	34
Annex C (informative) Influence of the measuring position and size of the specimen on resistance	35
C.1 Influence of the measuring position on resistance	35
C.2 Influence of the size of the specimen on resistance	
Bibliography	37
Figure 1 – Example of four-point probe measurement	20
Figure 2 – Example of four-probe measurement equipment	20
Figure 3 – Measuring positions of resistance (Type A)	22
Figure 4 – Measuring positions of resistance (Type B)	22
Figure 5 – Measuring positions of resistance (Type C)	23
Figure A.1 – Example of the internal structure of probe	32
Figure A.2 – Example of the general overall view of the probe	32
Figure B.1 – Schematic diagram of the geometry of the conductive layer and the configuration of probes A, B, C and D	
Figure C.1 – Measurement model for the influence of the measuring position on sheet resistance	35
Figure C.2 – Model measurement of the influence of the specimen size	36
Table 1 – Test methods for conductive inks used in PE	11
Table 2 – Resistance range of the test piece and the applied current	21
Table 3 – List of the size of the specimen	22

- 4 - IEC 62899-202:2023 RLV © IEC 2023

### INTERNATIONAL ELECTROTECHNICAL COMMISSION

### **PRINTED ELECTRONICS -**

Part 202: Materials - Conductive ink

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62899-202:2016. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

- 5 -

IEC 62899-202 has been prepared by IEC technical committee 119: Printed electronics. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) definitions of conductive material, conductive ink and conductive layer have been revised;
- b) a summary of test methods is added;
- c) mechanical tests for conductive layer are added.

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

Draft	Report on voting
119/423/FDIS	119/428/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 <a href="https://www.iec.ch/members\_experts/refdocs">www.iec.ch/members\_experts/refdocs</a>. The main document types developed by IEC are described in greater detail at <a href="https://www.iec.ch/publications">www.iec.ch/publications</a>.

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.

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- 6 - IEC 62899-202:2023 RLV © IEC 2023

### INTRODUCTION

The IEC 62899-20x series relates mainly to evaluation methods for materials of printed electronics. The series also include 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.

Printed electronics is a technology that spans the printing and electrical/electronic area, and it provides a variety of products. Since participants in this industry come from different areas, their backgrounds and customs can be barriers to smooth communication and transactions in the supply chain. The printed electronics industry continues to grow, but many barriers still remain. Particularly, the lack of standardised terms and evaluation methods is one of the major factors that inhibit smooth communication.

This document focuses on measurement and evaluation methods for conductive inks and provides tools to promote the smooth communication within the supply chain.

This document specifies the basic items to be communicated and their measurement or evaluation methods. This document includes the measurement methods for the basic properties of inks and electrical conductivity, which is obtained by the post treatment of inks. Additionally, storage methods, packaging and marking, and transportation conditions are also included.

This document is part of the IEC 62899-202 series and similar documents are available for other materials used in printed electronics.

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

IEC 62899-201: Materials - Substrates

IEC 62899-202: Materials - Conductive ink

IEC 62899-203: Materials – Semiconductor ink<sup>4</sup>

IEC 62899-204: Materials - Insulator ink

(Subsequent parts will be prepared for other materials.)

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

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

<sup>&</sup>lt;sup>1</sup>—Under consideration.

#### – 7 –

### PRINTED ELECTRONICS -

Part 202: Materials - Conductive ink

### 1 Scope

This part of IEC 62899 defines the terms and specifies the standard test methods for characterization and evaluation of conductive inks.

This International Standard is applicable to conductive inks and conductive layer that are made from conductive inks.

This document also provides measurement methods for evaluating the properties of conductive layers made both from an additive process using conductive inks and from a subtractive process used in printed electronics.

### 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 62899-202-3, Printed electronics – Part 202-3: Materials – Conductive ink – Measurement of sheet resistance of conductive films – Contactless method

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 124, Latex, rubber – Determination of total solids content

ISO 291, Plastics – Standard atmospheres for conditioning and testing

ISO 304, Surface active agents – Determination of surface tension by drawing up liquid films

ISO 489:<del>1999</del>2022, Plastics – Determination of refractive index

ISO 758, Liquid chemical products for industrial use – Determination of density at 20 degrees C

ISO 1183-1, Plastics – Methods for determining the density of non-cellular plastics – Part 1: Immersion method, liquid pycnometer method and titration method

ISO 2409:2020, Paints and varnishes – Cross-cut test

#### - 8 - IEC 62899-202:2023 RLV © IEC 2023

- ISO 2471, Paper and board Determination of opacity (paper backing) Diffuse reflectance method
- ISO 2555, Plastics Resins in the liquid state or as emulsions or dispersions Determination of apparent viscosity-by the Brookfield Test using a single cylinder type rotational viscometer method
- ISO 2592, Petroleum and related products Determination of flash and fire points Cleveland open cup method
- ISO 2719, Determination of flash point Pensky-Martens closed cup method
- ISO 2811-1, Paints and varnishes Determination of density Part 1: Pycnometer method
- ISO 2811-2, Paints and varnishes Determination of density Part 2: Immersed body (plummet) method
- ISO 2884-1, Paints and varnishes Determination of viscosity using rotary viscometers Part 1: Cone-and-plate viscometer operated at a high rate of shear
- 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 3251, Paints, varnishes and plastics Determination of non-volatile-matter content
- ISO 3451-1, Plastics Determination of ash Part 1: General methods
- ISO 3664, Graphic technology and photography Viewing conditions
- ISO 3679, Determination of flash no-flash and flash point Rapid equilibrium closed cup method
- ISO 4576, Plastics Polymer dispersions Determination of sieve residue (gross particle and coagulum content)
- ISO 9276-6, Representation of results of particle size analysis Part 6: Descriptive and quantitative representation of particle shape and morphology
- ISO 11664-4, Colorimetry Part 4: CIE 1976 L\*a\*b\* colour space
- ISO 13319, Determination of particle size distributions Electrical sensing zone method
- ISO 13320, Particle size analysis Laser diffraction methods
- ISO 13321, Particle size analysis Photon correlation spectroscopy
- ISO 13322-1, Particle size analysis Image analysis methods Part 1: Static image analysis methods
- ISO 13468-1:<del>1996</del>2019, Plastics Determination of the total luminous transmittance of transparent materials Part 1: Single beam instrument
- ISO 13468-2:<del>1999</del>2021, Plastics Determination of the total luminous transmittance of transparent materials Part 2: Double-beam instrument

IEC 62899-202:2023 RLV © IEC 2023 - 9

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

ISO 14488, Particulate materials – Sampling and sample splitting for the determination of particulate properties

ISO 14782, Plastics – Determination of haze for transparent materials

ISO 14887, Sample preparation – Dispersing procedures for powders in liquids

ISO 15212-1, Oscillation-type density meters – Part 1: Laboratory instruments

ISO 18947-1:2021, Imaging materials and prints – Abrasion resistance – Part 1: General rub testing methods

ISO 20379, Fine ceramics (advanced ceramics, advanced technical ceramics) – Measurement of thixotropic behaviour of ceramic slurry by use of a rotational viscometer

ISO 20998-1, Measurement and characterization of particles by acoustic methods – Part 1: Concepts and procedures in ultrasonic attenuation spectroscopy



# IEC 62899-202

Edition 2.0 2023-05

# INTERNATIONAL STANDARD

Printed electronics -

Part 202: Materials - Conductive ink



### – 2 –

### **CONTENTS**

2     Normative references     .7       3     Terms and definitions     .9       4     Atmospheric conditions for evaluation and pre-conditioning     .11       5     Summary characteristics and evaluation method of conductive ink     .11       6     Evaluation of properties of conductive ink     .12       6.1     Specimen     .12       6.2     Contents     .12       6.2.1     Solid content     .12       6.2.2     Non-volatile content     .12       6.2.3     Ash content     .13       6.2.4     Foreign matter     .13       6.3     Physical properties     .14       6.3.1     Density     .14       6.3.2     Rheology     .14       6.3.3     Surface tension     .15       6.3.4     Size of conductive materials     .16       6.3.5     Flashpoint     .17       6.3.6     Evaporation rate     .18       6.3.7     Appearance of ink     .19       7     Textual attence     .19       7.1.1     General     .19       7.1.2     Substrate     .19 <th>Ε(</th> <th>DREWOR</th> <th>D</th> <th>4</th>	Ε(	DREWOR	D	4
2     Normative references	IN	TRODUC	TION	6
3       Terms and definitions       9         4       Atmospheric conditions for evaluation and pre-conditioning       11         5       Summary characteristics and evaluation method of conductive ink       11         6       Evaluation of properties of conductive ink       12         6.1       Specimen       12         6.2       Contents       12         6.2.1       Solid content       12         6.2.2       Non-volatile content       12         6.2.3       Ash content       13         6.2.4       Foreign matter       13         6.3       Physical properties       14         6.3.1       Density       14         6.3.2       Rheology       14         6.3.3       Surface tension       15         6.3.4       Size of conductive materials       16         6.3.5       Flashpoint       17         6.3.6       Evaporation rate       18         6.3.7       Appearance of ink       19         7       Evaluation of the properties of a conductive layer       19         7.1.1       General       19         7.1.2	1	Scope.		7
4 Atmospheric conditions for evaluation and pre-conditioning	2	Normat	ive references	7
5       Summary characteristics and evaluation method of conductive ink       11         6       Evaluation of properties of conductive ink       12         6.1       Specimen       12         6.2       Contents       12         6.2.1       Solid content       12         6.2.2       Non-volatile content       13         6.2.3       Ash content       13         6.2.4       Foreign matter       13         6.3       Physical properties       14         6.3.1       Density       14         6.3.2       Rheology       14         6.3.3       Surface tension       15         6.3.4       Size of conductive materials       16         6.3.5       Flashpoint       17         6.3.6       Evaporation rate       18         6.3.7       Appearance of ink       19         7       Evaluation of the properties of a conductive layer       19         7.1       Test piece       19         7.1.1       General       19         7.1.2       Substrate       19         7.1.5       Preparation of test piece       19	3	Terms	and definitions	9
5       Summary characteristics and evaluation method of conductive ink       11         6       Evaluation of properties of conductive ink       12         6.1       Specimen       12         6.2       Contents       12         6.2.1       Solid content       12         6.2.2       Non-volatile content       13         6.2.3       Ash content       13         6.2.4       Foreign matter       13         6.3       Physical properties       14         6.3.1       Density       14         6.3.2       Rheology       14         6.3.3       Surface tension       15         6.3.4       Size of conductive materials       16         6.3.5       Flashpoint       17         6.3.6       Evaporation rate       18         6.3.7       Appearance of ink       19         7       Evaluation of the properties of a conductive layer       19         7.1       Test piece       19         7.1.1       General       19         7.1.2       Substrate       19         7.1.5       Preparation of test piece       19	4	Atmosp	pheric conditions for evaluation and pre-conditioning	11
6     Evaluation of properties of conductive ink.     12       6.1     Specimen.     12       6.2     Contents     12       6.2.1     Solid content     12       6.2.3     Ash content     13       6.2.4     Foreign matter     13       6.3     Physical properties     14       6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2.1     Volume resistivity (based on the four-point probe method)     24				
6.1     Specimen.     12       6.2     Contents.     12       6.2.1     Solid content     12       6.2.2     Non-volatile content     12       6.2.3     Ash content     13       6.2.4     Foreign matter     13       6.3     Physical properties     14       6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resi				
6.2 Contents     12       6.2.1 Solid content     12       6.2.2 Non-volatile content     12       6.2.3 Ash content     13       6.2.4 Foreign matter     13       6.3 Physical properties     14       6.3.1 Density     14       6.3.2 Rheology     14       6.3.3 Surface tension     15       6.3.4 Size of conductive materials     16       6.3.5 Flashpoint     17       6.3.6 Evaporation rate     18       6.3.7 Appearance of ink     19       7 Evaluation of the properties of a conductive layer     19       7.1 Test piece     19       7.1.1 General     19       7.1.2 Substrate     19       7.1.3 Conductive ink     19       7.1.4 Dimensions of test piece     19       7.1.5 Preparation of test piece     19       7.2.1 Volume resistivity (based on the four-point probe method)     24       7.2.2 Surface resistivity (based on the contactless method)     25       7.3.1 Bending test     25       7.3.2 Abrasion resistance     26       7.3.3 Adhesion strength     27       7.4.1 Overview     27	U		• •	
6.2.1     Solid content     12       6.2.2     Non-volatile content     12       6.2.3     Ash content     13       6.2.4     Foreign matter     13       6.3     Physical properties     14       6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method) </td <td></td> <td></td> <td>•</td> <td></td>			•	
6.2.2     Non-volatile content.     12       6.2.3     Ash content     13       6.2.4     Foreign matter     13       6.3     Physical properties     14       6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2.1     Volume resistivity     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3.1     Bending test     25 </td <td></td> <td></td> <td></td> <td></td>				
6.2.3     Ash content     13       6.2.4     Foreign matter     13       6.3     Physical properties     14       6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25		-		
6.2.4     Foreign matter     13       6.3     Physical properties     14       6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity (based on the four-point probe method)     24       7.2.2     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resist				
6.3     Physical properties     14       6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4.1     Overview     27				
6.3.1     Density     14       6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4.1     Overview </td <td></td> <td></td> <td><u> </u></td> <td></td>			<u> </u>	
6.3.2     Rheology     14       6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity (based on the four-point probe method)     24       7.2.2     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4.1     Overview     27       7.4.2     Luminous				
6.3.3     Surface tension     15       6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1			•	
6.3.4     Size of conductive materials     16       6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3			<b>.</b>	
6.3.5     Flashpoint     17       6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniform				
6.3.6     Evaporation rate     18       6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     U				
6.3.7     Appearance of ink     19       7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     <			•	
7     Evaluation of the properties of a conductive layer     19       7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive			·	
7.1     Test piece     19       7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31  <	7		• •	
7.1.1     General     19       7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31	•		· · ·	
7.1.2     Substrate     19       7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31			•	
7.1.3     Conductive ink     19       7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31				
7.1.4     Dimensions of test piece     19       7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31				
7.1.5     Preparation of test piece     19       7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31				
7.2     Electrical properties     20       7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31			•	
7.2.1     Volume resistivity     20       7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31			·	
7.2.2     Surface resistivity (based on the four-point probe method)     24       7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31			• •	
7.2.3     Surface resistivity (based on the contactless method)     25       7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31			•	
7.3     Mechanical properties     25       7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31		7.2.3	• • • • • • • • • • • • • • • • • • • •	
7.3.1     Bending test     25       7.3.2     Abrasion resistance     26       7.3.3     Adhesion strength     27       7.4     Optical properties     27       7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31		7.3 M		
7.3.2 Abrasion resistance     26       7.3.3 Adhesion strength     27       7.4 Optical properties     27       7.4.1 Overview     27       7.4.2 Luminous transmittance     27       7.4.3 Chromaticity     28       7.4.4 Uniformity of colour     28       7.4.5 Haze     30       7.4.6 Refractive index     30       8 Storage     31			·	
7.4 Optical properties     27       7.4.1 Overview     27       7.4.2 Luminous transmittance     27       7.4.3 Chromaticity     28       7.4.4 Uniformity of colour     28       7.4.5 Haze     30       7.4.6 Refractive index     30       8 Storage     31		7.3.2	-	
7.4.1     Overview     27       7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31		7.3.3		
7.4.2     Luminous transmittance     27       7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31		7.4 O	ptical properties	27
7.4.3     Chromaticity     28       7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31		7.4.1	Overview	27
7.4.4     Uniformity of colour     28       7.4.5     Haze     30       7.4.6     Refractive index     30       8     Storage     31		7.4.2	Luminous transmittance	27
7.4.5 Haze		7.4.3	Chromaticity	28
7.4.6     Refractive index		7.4.4	Uniformity of colour	28
8 Storage		7.4.5	Haze	30
-		7.4.6	Refractive index	30
8.1 Storage conditions 31	8	Storage	э	31
o. r otorago conditionoor		8.1 S	torage conditions	31

8.2 Method for measuring aged deterioration	31
8.3 Report of the results	31
Annex A (informative) Example of four-point probe for applying an appropriate weight	32
A.1 Internal structure	32
A.2 Example of overall view	32
Annex B (informative) Formula of correction factor F	33
B.1 General	33
B.2 Conditions for correction factor F	34
B.3 Formula of correction factor F	34
Annex C (informative) Influence of the measuring position and size of the specimen on resistance	35
C.1 Influence of the measuring position on resistance	35
C.2 Influence of the size of the specimen on resistance	36
Bibliography	37
Figure 1 – Example of four-point probe measurement	20
Figure 2 – Example of four-probe measurement equipment	20
Figure 3 – Measuring positions of resistance (Type A)	22
Figure 4 – Measuring positions of resistance (Type B)	22
Figure 5 – Measuring positions of resistance (Type C)	23
Figure A.1 – Example of the internal structure of probe	32
Figure A.2 – Example of the overall view of the probe	
Figure B.1 – Schematic diagram of the geometry of the conductive layer and the configuration of probes A, B, C and D	
Figure C.1 – Measurement model for the influence of the measuring position on sheet resistance	35
Figure C.2 – Model measurement of the influence of the specimen size	36
Table 1 – Test methods for conductive inks used in PE	11
Table 2 – Resistance range of the test piece and the applied current	21
Table 3 – List of the size of the specimen	22

### INTERNATIONAL ELECTROTECHNICAL COMMISSION

### **PRINTED ELECTRONICS -**

Part 202: Materials - Conductive ink

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IEC 62899-202 has been prepared by IEC technical committee 119: Printed electronics. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) definitions of conductive material, conductive ink and conductive layer have been revised;
- b) a summary of test methods is added;
- c) mechanical tests for conductive layer are added.

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- 5 -

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

Draft	Report on voting
119/423/FDIS	119/428/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 <a href="https://www.iec.ch/members\_experts/refdocs">www.iec.ch/members\_experts/refdocs</a>. The main document types developed by IEC are described in greater detail at <a href="https://www.iec.ch/publications">www.iec.ch/publications</a>.

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.

### INTRODUCTION

– 6 –

Printed electronics is a technology that spans the printing and electrical/electronic area, and it provides a variety of products. Since participants in this industry come from different areas, their backgrounds and customs can be barriers to smooth communication and transactions in the supply chain. The printed electronics industry continues to grow, but many barriers still remain. Particularly, the lack of standardised terms and evaluation methods is one of the major factors that inhibit smooth communication.

This document focuses on measurement and evaluation methods for conductive inks and provides tools to promote the smooth communication within the supply chain.

This document specifies the basic items to be communicated and their measurement or evaluation methods. This document includes the measurement methods for the basic properties of inks and electrical conductivity, which is obtained by the post treatment of inks. Additionally, storage methods, packaging and marking, and transportation conditions are also included.

This document is part of the IEC 62899-202 series and similar documents are available for other materials used in printed electronics.

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

IEC 62899-201: Materials - Substrates

IEC 62899-202: Materials - Conductive ink

IEC 62899-203: Materials - Semiconductor ink

IEC 62899-204: Materials - Insulator ink

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

**-7-**

### PRINTED ELECTRONICS -

Part 202: Materials - Conductive ink

### 1 Scope

This part of IEC 62899 defines the terms and specifies the standard test methods for characterization and evaluation of conductive inks.

This document also provides measurement methods for evaluating the properties of conductive layers made both from an additive process using conductive inks and from a subtractive process used in printed electronics.

### 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 62899-202-3, Printed electronics – Part 202-3: Materials – Conductive ink – Measurement of sheet resistance of conductive films – Contactless method

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 124, Latex, rubber – Determination of total solids content

ISO 291, Plastics – Standard atmospheres for conditioning and testing

ISO 304, Surface active agents – Determination of surface tension by drawing up liquid films

ISO 489:2022, Plastics – Determination of refractive index

ISO 758, Liquid chemical products for industrial use – Determination of density at 20 degrees C

ISO 1183-1, Plastics – Methods for determining the density of non-cellular plastics – Part 1: Immersion method, liquid pycnometer method and titration method

ISO 2409:2020, Paints and varnishes - Cross-cut test

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

- ISO 2555, Plastics Resins in the liquid state or as emulsions or dispersions Determination of apparent viscosity using a single cylinder type rotational viscometer method
- ISO 2592, Petroleum and related products Determination of flash and fire points Cleveland open cup method
- ISO 2719, Determination of flash point Pensky-Martens closed cup method
- ISO 2811-1, Paints and varnishes Determination of density Part 1: Pycnometer method
- ISO 2811-2, Paints and varnishes Determination of density Part 2: Immersed body (plummet) method
- ISO 2884-1, Paints and varnishes Determination of viscosity using rotary viscometers Part 1: Cone-and-plate viscometer operated at a high rate of shear
- 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 3251, Paints, varnishes and plastics Determination of non-volatile-matter content
- ISO 3451-1, Plastics Determination of ash Part 1: General methods
- ISO 3664, Graphic technology and photography Viewing conditions
- ISO 3679, Determination of flash no-flash and flash point Rapid equilibrium closed cup method
- ISO 4576, Plastics Polymer dispersions Determination of sieve residue (gross particle and coagulum content)
- ISO 9276-6, Representation of results of particle size analysis Part 6: Descriptive and quantitative representation of particle shape and morphology
- ISO 11664-4, Colorimetry Part 4: CIE 1976 L\*a\*b\* colour space
- ISO 13319, Determination of particle size distributions Electrical sensing zone method
- ISO 13320, Particle size analysis Laser diffraction methods
- ISO 13321, Particle size analysis Photon correlation spectroscopy
- ISO 13322-1, Particle size analysis Image analysis methods Part 1: Static image analysis methods
- ISO 13468-1:2019, Plastics Determination of the total luminous transmittance of transparent materials Part 1: Single beam instrument
- ISO 13468-2:2021, Plastics Determination of the total luminous transmittance of transparent materials Part 2: Double-beam instrument
- ISO 13655, Graphic technology Spectral measurement and colorimetric computation for graphic arts images

**-9-**

ISO 14488, Particulate materials – Sampling and sample splitting for the determination of particulate properties

ISO 14782, Plastics – Determination of haze for transparent materials

ISO 14887, Sample preparation – Dispersing procedures for powders in liquids

ISO 15212-1, Oscillation-type density meters – Part 1: Laboratory instruments

ISO 18947-1:2021, Imaging materials and prints – Abrasion resistance – Part 1: General rub testing methods

ISO 20379, Fine ceramics (advanced ceramics, advanced technical ceramics) – Measurement of thixotropic behaviour of ceramic slurry by use of a rotational viscometer

ISO 20998-1, Measurement and characterization of particles by acoustic methods – Part 1: Concepts and procedures in ultrasonic attenuation spectroscopy