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INTERNATIONAL STANDARD

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

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

Draft	Report on voting
119/342/FDIS	119/345/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.

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- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

A printed layer on a flexible substrate is widely employed as an electrode or interconnection for flexible devices. An integral component of this conductive body of the devices is conductive composite material and is commercialized as conductive ink.

A simple tape test method has been widely used for qualitative adhesion measurement, but it cannot be used to measure strong adhesion between the printed layer and the flexible substrate.

A conventional peel test method is widely used in the printed circuits industry to evaluate the adhesion between a thin printed layer with dense microstructure and the flexible substrate.

Peel strength value can be measured after an additional metal electroplating process on a thin printed layer to increase the printed layer thickness to provide a stable grip in an adhesion testing machine. However, it is not suitable for testing a printed layer which has a porous structure susceptible to contamination of the interface between the printed layer and flexible substrate during the electroplating process.

Therefore, a quantitative and reliable adhesion test method is used to measure and understand interfacial adhesion of the printed layer to the flexible substrate and its long-term reliability.

In this document, a new standard test method to measure the peel strength of a printed layer on a flexible substrate is proposed. This method calls for peeling the flexible substrate instead of an additional metal electroplating on the printed layer. It is useful to monitor and compare the thickness dependence of the peel strength of a layer on the same flexible substrate.

PRINTED ELECTRONICS –

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1 Scope

This part of IEC 62899 provides a test method to measure the peel strength of a printed layer on a flexible substrate. This method calls for peeling the flexible substrate instead of an additional metal electroplating on the printed layer. The method described in this document can be used to compare the peel strengths of the printed layers on the same flexible substrate and thickness conditions. It can be used when the adhesion between the printed layer and flexible substrate is weaker than any other interface between the printed layer and the adhesive, the adhesive and the panel.

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 62899-202:2016, *Printed electronics – Part 202: Materials – Conductive ink*

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
conductive material
ingredient of a printing or coating material, which itself is electrically conductive or becomes electrically conductive by post treatment such as heating

[SOURCE: IEC 62899-202:2016, 3.1]

3.2
conductive ink
printable fluid intended for printing in which one or more molecules, polymers, or particles are dissolved or dispersed, which becomes an electrically conductive layer by post treatment such as heating

[SOURCE: IEC 62899-202:2016, 3.2, modified – in the definition, "fluid" has been replaced with "printable fluid intended for printing".]

3.3
printed layer
conductive body made of conductive ink and of uniform thickness which is very small in proportion to length and width

EXAMPLE Printed Ag, printed Cu.

3.4
peel strength
strength required to separate the printed layer from the flexible substrate at a constant pulling force

Note 1 to entry: Peel strength is calculated as the average peel load/sample width.

Note 2 to entry: Average peel load is obtained by several measurements at a steady state load displacement after the initial load increase.

3.5
flexible substrate
substrate with flexibility such that it can bend during the 90º peel test and on which conductive ink is printed

Note 1 to entry: Examples of flexible polymers are polyimide, polyethylene terephthalate, polyethylene naphthalate, and polyester).

4 Standard atmospheric conditions

Standard atmospheric conditions for measurement for the peel strength of a printed layer on flexible substrate shall apply as specified in IEC 62899-202:2016, Clause 4:

a) temperature: (23 ± 2) ºC
b) relative humidity: (50 ± 5) %

5 Test sample

5.1 General

The test sample for the peel strength test shall be prepared using a printed layer on a flexible substrate.

5.2 Size of test sample

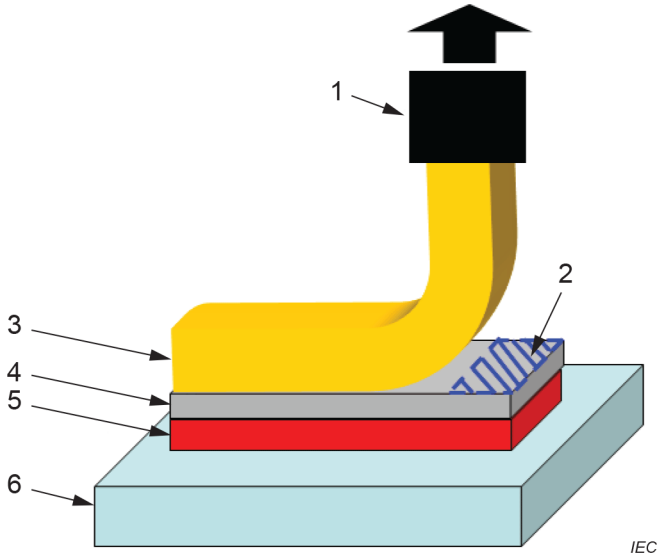
For uniform adhesion test, a rectangular shape is recommended. The size of the test panel can be 50 mm × 120 mm, for example. Stable peel strength data can be obtained with substrate thickness ranges from 25 µm to 125 µm. The size of the printed layer shall be 10 mm ± 0,2 mm in width and 100 mm in length. Measure the print width on three positions to 0,1 mm accuracy and use the average width for peel strength calculation.

5.3 Applicability of the method

The schematic of the peel test is illustrated in Figure 1. With the peel test, the adhesion between printed layer and flexible substrate can be measured. The flexible substrate is fixed by narrowing the gap in the grip part in Figure 1. This measurement method is applicable only when the peel strength between the flexible substrate and the printed layer is smaller than the cohesive force of the printed layer, the peel strength between the printed layer and adhesive, the peel strength between the adhesive and panel and the strength of the flexible substrate.

- F (sub-layer) < F (layer), F (layer-ad), F (ad-panel), F(sub);
- F (sub-layer): peel strength between the flexible substrate and printed layer;

- F (layer): cohesive force of the printed layer;
- F (layer-ad): peel strength between the printed layer and adhesive;
- F (ad-panel): peel strength between the adhesive and test panel;
- F (sub): tension strength of the flexible substrate.



1 Grips
2 Initial delamination
3 Flexible substrate
4 Printed layer
5 Adhesive
6 Test panel

Figure 1 – Schematic of peel test of the printed layer on a flexible substrate

6 Testing method and test apparatus

6.1 General

The 90° adhesion test requires a 90° peel tester fixture to determine the adhesive strength between a flexible substrate and printed layer, where the printed layer lies together with the flexible substrate on the test panel. The gripped end of the flexible substrate is stuck on perpendicularly to the printed layer while the rest of the substrate is bonded to the printed layer so that it forms a 90° bend.

6.2 Test apparatus

Using a peel tester as shown in Figure 2, a peeling force shall be applied to a flexible substrate. As shown in Figure 2, a peel tester to apply a peeling motion on samples shall be used. The linear length shall be at least 50 mm.