IEC TR 62899-250

Edition 2.0 2025-03

TECHNICAL REPORT

Printed electronics –
Part 250: Material technologies required in printed electronics for wearable smart devices

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PRINTED ELECTRONICS –

Part 250: Material technologies required in printed electronics for wearable smart devices

FOREWORD

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IEC TR 62899-250 has been prepared by IEC technical committee 119: Printed electronics. It is a Technical Report.

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) added classification of e-textile integrated type;
b) added Clause 5, “Verification of conclusions in IEC TR 62899-250:2016 (edition 1)”;
c) added explanation of 3D printed circuits;

d) introduced trends in standardization activities, especially those after the first edition publication;

e) added new issues that became clear after the first edition was published.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
119/509/DTR	119/536/RVDTR

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 Technical Report 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/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- withdrawn, or
- revised.

INTRODUCTION

IEC TR 62899-250 (edition 1), published in 2016, discussed and summarized the applicability of printed electronics technology in the rapidly expanding area of wearable electronics and the concomitant need for standardization of new measurement methods. Many of the issues raised by the TR regarding the need for new standardization have actually been developed and have already been published as international standards.

The establishment of IEC/TC 124 in 2017 is a particularly noteworthy event in this standardization field. And multiple industrial organizations have progressed standardization activities in flexible electronics field that span both wearable and printed electronics.

During this period, the evolution of this technology field has accelerated, and new technologies are being introduced one after another. Therefore, there is no change in the situation where there is an ongoing need for new standards.

The second edition of this document, following the first edition, aims to provide guidance for future standardization work on wearable and printed electronic. And standardization activities in the field of both printed and wearable electronics are reviewed from a global perspective, in order to prevent standardization conflicts between different standardization organizations.

PRINTED ELECTRONICS –

Part 250: Material technologies required in printed electronics for wearable smart devices

1 Scope

This part of IEC 62899, which is a Technical Report, explores a new technological field to establish standardization activities in TC 119 (Printed electronics) in particular, and to contribute to the development and market expansion of wearable smart device (WSD) technology.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

4 Wearable smart devices

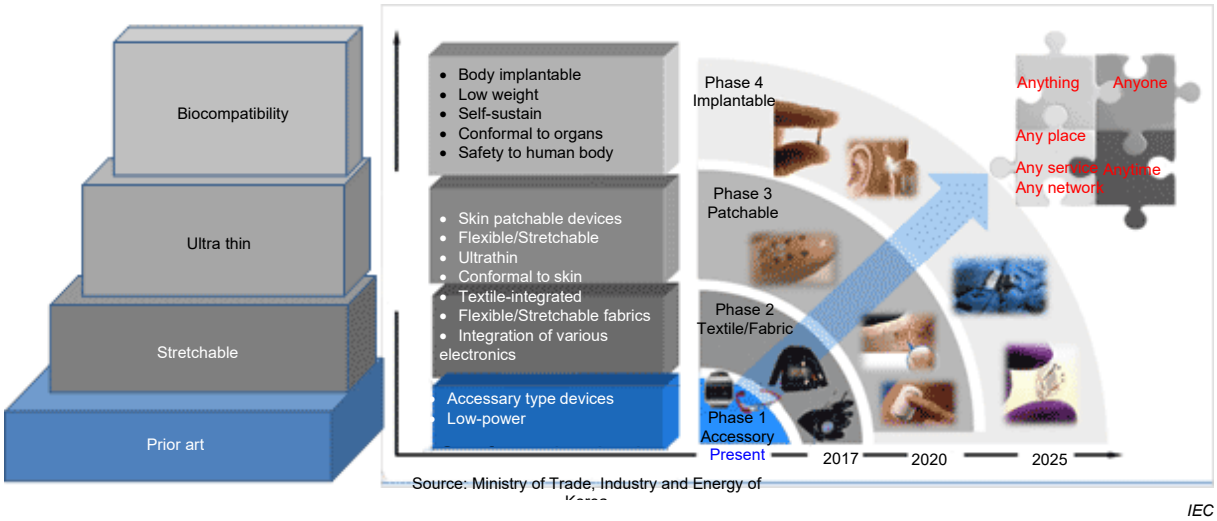
4.1 General

Wearable smart devices are a newly evolving electronic application field where standards for conventional electronic devices might not be smoothly applicable. In this new field, electronic devices are applied or attached directly to the human body like eyewear, contrary to conventional electronic devices, such as TV sets, that are most likely to be used away from the body. Due to the particular characteristics of the human body, these new devices are required to have new physical characteristics, such as flexibility and salt resistance (anti-sweat). In order to address those demands, the electronics industry has come up with new processes to produce those new devices.

NOTE The expression "wearable smart devices" is abbreviated as "WSD" in this document.

4.2 Categorization

Figure 1 shows an overview of WSDs, including categorization and examples. This graphic introduces categories based upon characteristics, such as ”prior art”, ”stretchable”, ”ultra-thin” and ”biocompatibility”, and some examples in each category. Technologies and challenges for those examples are discussed in 5.2 to 5.5.



[SOURCE: Ministry of Trade, Industry and Energy of Korea]

Figure 1 – Wearable smart devices technologies and market[1]

4.3 Accessory type devices

Accessory type devices are designed to be a good fit for the shapes of the human body. The major functions of these devices are to acquire vital data or movement, or both, of the body, and to transfer data to other devices or networks, or both, without human interaction, unlike cell phones or portable music players, which require human interaction. For example, the following WSDs are already commercialized:

- bracelets, watches and wristbands;
- eyewear and headmounted devices;
- earphones;
- finger rings, necklaces and the like;
- footwear in-soles

In order to realize these devices, adaptation of the following characteristics is required:

– a small footprint,
– lightness,
– low power,
– mechanical flexibilities to follow body movement, and
– if needed, display functions with high resolution or mechanical flexibilities, or both.

Obviously and most importantly, in addition to fulfilling these electrical or mechanical needs, additional safety requirements and regulations need to be developed, since WSDs will operate in close contact with the human body.

[1] Reproduced with the permission of Ministry of Trade, Industry and Energy of Korea.

4.4 Textile integrated type

Textile integrated type WSDs combine integrated biomedical signal acquisition functions with communication functions attached to clothing such as sportswear or underwear. This type of WSD needs complementary technologies compatible with the electronic components and textile products that make up the clothes. Specifically, highly flexible and stretchable wiring technologies are required. Furthermore, electronic components need to withstand stresses similar to those general clothing is subjected to, such as stresses which occur during washing and drying.

Textile-integrated WSDs are classified as follows, depending on the degree to which electronic components or devices are integrated on or into textile materials or products:

– Integration level 1 (removable solution)

  The electronic (textile) component is attached in a way that it can be detached without destruction of the product. Examples for integration level 1 electronic textile systems are attachment of the electronic (textile) component by inserting in a dedicated pocket or by attaching it via, for example, close fasteners or push buttons.

– Integration level 2 (attached solution)

  The electronic device is attached to textile in a way that it is not removable without destroying the products. Examples for attachment methods are stitching, welding, gluing.

– Integration level 3 (mixed solution)

  The electronic textile system comprises an electronic device which consists of one or more electronic components which are made using textile or textile finishing technologies and which can be combined with permanently or non-permanently attached electronic components.

– Integration level 4 (full textile solution)

  All components of the electronic device are made using textile or textile finishing technologies.

NOTE This level classification is based on [1] and [2][2].

4.5 Skin patchable type

WSD types used in patches directly applied to the skin or mucous membranes of the body surface have been proposed. Such WSDs, in addition to the necessities of functional shape and flexibility, require technology for obtaining very thin electronic elements. Additionally, in order to evaluate the very thin electronic elements, new evaluation methods will be required.

Furthermore, because these types of WSDs are in continuous direct contact with the human body, they require resistance to secretions from the body such as sweat or saliva.

4.6 Body implantable type

In Figure 1, WSDs are shown to be expected to eventually develop into types which are implanted into the human body. High biocompatibility is required for WSDs at this stage.

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2 Numbers in square brackets refer to the Bibliography.