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Nanomanufacturing — Key control characteristics

Part 5-1: Thin-film organic/nano electronic devices — Carrier transport measurements

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TECHNICAL SPECIFICATION



**Nanomanufacturing – Key control characteristics –
Part 5-1: Thin-film organic/nano electronic devices – Carrier transport
measurements**

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ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 5-1: Thin-film organic/nano electronic devices – Carrier transport measurements

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62607-5-1, which is a technical specification, has been prepared by IEC technical committee 113: Nanotechnology standardization for electrical and electronic products and systems.

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The text of this technical specification is based on the following documents:

| | |
|---------------|------------------|
| Enquiry draft | Report on voting |
| 113/212/DTS | 113/221/RVC |

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 62607 series, published under the general title *Nanomanufacturing key control characteristics*, can be found on the IEC website.

The committee has decided that the contents of this publication 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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Organic/nano thin-film devices have many attractive features such as being light-weight and flexible, and having a low-cost, low-temperature fabrication process. Organic/nano electronic devices have been widely researched by academic institutions, research institutes, and materials and device industries. One of their possible applications is therefore expected to be in flexible and rollable devices. Many thin-film transistors based on organic semiconductor materials, called organic thin-film transistors (OTFTs), are expected to be mounted on organic electroluminescence display to drive each organic light-emitting diode pixel circuit. These OTFTs are also promising candidates for molecular nanoelectronics.

OTFTs show a relatively smaller carrier mobility (thin-film mobility: at most $10 \text{ cm}^2/\text{Vs}$, but usually less than $1 \text{ cm}^2/\text{Vs}$) compared with other thin-film transistors based on inorganic semiconductors (silicon, III-V compounds, metal oxides). Carrier transport properties such as thin-film mobility and thin-film carrier concentration in OTFTs are usually measured by simply applying the device physics of silicon metal-oxide-semiconductor transistors to OTFTs. Both the intrinsic bulk mobility of organic semiconductors and extrinsic effects such as contact resistance, carrier trap, interface, and surface state can limit thin-film mobility in OTFTs. Therefore, reliable methods of evaluating carrier transport properties for nanometer-scale thin-film materials have not yet been established and urgently need to be developed.

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NANOMANUFACTURING – KEY CONTROL CHARACTERISTICS –

Part 5-1: Thin-film organic/nano electronic devices – Carrier transport measurements

1 Scope

This part of IEC 62607, which is a Technical Specification, provides a standardized sample structure for characterizing charge transport properties in thin-film organic/nano electronic devices and a format to report details of the structure which shall be provided with the measurement results. The standardized OTFT testing structure with a contact-area-limited doping can mitigate contact resistance and enable reliable measurement of the charge carrier mobility. The purpose of this Technical Specification is to provide test sample structures for determining the intrinsic charge transport properties of organic thin-film devices. The intention is to provide reliable materials information for OTFTs and to set guidelines for making test sample structures so that materials information is clear and consistent throughout the research community and industry.

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 <http://www.electropedia.org/>)

IEC 62860, *Test methods for the characterization of organic transistors and materials*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in IEC 60050-521 as well as the following apply.

3.1 Terms and definitions

3.1.1

organic thin-film transistor

OTFT

field-effect transistor that has a conduction channel made of thin films consisting of organic compounds

3.1.2

thin-film mobility

charge carrier mobility of the conduction channel (the semiconductor layer) in an OTFT

3.1.3

contact-area-limited doping

doping at around interface regions between the source and drain electrodes and the conduction channel in an OTFT