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CURRENT LANDSCAPE OF STANDARDISATION EFFORTS IN ORGANIC AND PRINTED ELECTRONICS 2015 – A VAMAS REVIEW

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SUMMARY

Organic and printed electronics relates to emerging electronics beyond silicon technology. In this growing multibillion Euros market, the need for new standards has led to the creation of multiple working groups within various standardisation forums. The dispersed nature of these activities makes it challenging for companies to find relevant standards and to engage with standardisation work. The aim of this report is to provide an overview of the landscape of standardisation efforts and a brief summary of the activities of these groups.

This document does not intend to completely cover all aspects of standardisation for organic and printed electronics and in that respect will focus on some areas more than others. Items covered include testing of flexible printed electronic devices, functional/electronic inks (e.g. carbon nanotubes, metal nanoparticles, graphene…), characterisation of organic light emitting diodes (device level and displays), photovoltaics (device level), thin film transistors and barrier layers. The report also includes information on how companies can obtain technology verification when no standards exist. A list of current standards and proposed work items within relevant standardisation groups is presented and a heat-map of activities provides a visual guide to the distribution of activities among the different groups. Topics related to complete products; product components (e.g. inverters, cables…) and safety are not covered in this document.

This document was created as part of activities of Technical Working Area 36 Organic Electronics of the Versailles Project on Advanced Materials and Standards (VAMAS). We invite the international community to send criticisms/suggestions that will be taken into account when publishing a revised version of this report.

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1 ORGANIC AND PRINTED ELECTRONICS

The term *organic and printed electronics* refers to electronics beyond the classical silicon approach, also known as *plastic electronics* or *emerging electronics*. The scope includes applications of organic (carbon-based) conductors and semiconductors, hybrid systems incorporating both organic and inorganic materials, and printed electronics, including nanoparticle based inks (e.g. metal, carbon nanotubes, graphene…). The advantageous characteristics of this broad spectrum of materials are the potential for easy design of chemical and physical properties and the possibility of processing from solution, such that printing and coating methods can be used to produce functional ultrathin film materials and devices. In that sense, functional 3D printing would also be included in the scope defined here. The ability to be printed, combined with good mechanical properties and low weight of these materials, allows deposition on a range of different substrates (e.g. glass, plastic, paper, metal sheet…) and the integration of these functional surfaces in numerous types of products.

2 LANDSCAPE OF STANDARDISATION EFFORTS

The fast pace of this growing industry, combined with the flexibility of product design poses a challenge to standardisation. At the same time the need for standards increases as more organic electronic based products reach the market. Due to the numerous possible applications of organic electronics, standardisation efforts are currently dispersed among several working groups across different institutions worldwide. The challenge is to avoid the development of isolated and competing standards and associated avoid duplication of effort. This document attempts to map that landscape with the hope of providing an easy reference for those developing new organic electronics products.

The effort of different working groups covered in this document can be classified in two categories:

- Pre-standardisation (white papers, protocols, peer reviewed papers, best practice guides, Round Robins)
- Standardisation (draft and complete standards)

Additionally, information on available schemes for product validation where standards are not yet available will be briefly introduced and a graphical representation (heat-map) of activities will be presented as a quick information guide.

2.1 HEAT MAP OF STANDARDISATION EFFORTS RELATED TO ORGANIC ELECTRONICS

Organic and Printed Electronics - Heat map of standardisation efforts 2015

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Standardisation committee	Nanomaterials (CNT, Graphene, Metal Inks) and Organic Semicondutors		Organic Photovoltaics		Organic Light Emitting Diodes		Thin Film Transistors		Displays (not including OLEDs)		Other Flexible Electronic Applications (e.g. Batteries, Smart Cards…)		Substrates and Encapsulants (including Barrier Layers)		Processing/ Manufacturing		Generic Printed Electronics and Other Topics	
	Published	Upcoming	Published	Upcoming	Published	Upcoming	Published	Upcoming	Published	Upcoming	Published	Upcoming	Published	Upcoming	Published	Upcoming	Published	Upcoming
ASTM C16.33													1					
ASTM D01.23													1					
ASTM E44.09			6	1														
ASTM F02.10													2					
CIE TC 2						2												
IEC TC 110					8	5			3	11							2	1
IEC TC 113	5	14		2			2									2	2	
IEC TC 119		2				1		1				2		1		5		1
IEC TC 34/ SC 34A					1	2												
IEC TC 47																	1	1
IEC TC 82			8	9														
IEC TC 91	1																	1
IEEE 1620							1	1										1
IPC D-60																	3	
ISO/TC 6/SC 2													1					
ISO/TC 61													6	3				
Pre-standardisation committees																		
EERA JP PV SP3			✔															
OE-A Encapsulation WG													✔					
OE-A Organic Electronics Energy			✔															
VAMAS TWA36	✔																✔	

Figure 1: Heat map of standardisation efforts related to organic electronics. Colours are visual guides to the level of activity/output from each working group: high (red), medium (orange), low (blue). Values indicate number of relevant documents generated (published) or planned as of March 2015, based on information available publicly.

2.2 RELEVANT STANDARDISATION WORKING GROUPS

Membership of international standards organisations (e.g. ISO, IEC…) is by country. Therefore individuals interested in engaging in standardisation work should contact their national standards office or national contact point in order to join the national mirror committees. The national standards organisations will then select experts from these national committees to represent the country on the international committees.

The list below includes those standardisation committees developing standards, specifications and technical reports relevant to organic electronics (in alphabetical order).

2.2.1 ASTM Committee C16 on Thermal Insulation (Subcommittee C16.33 on Insulation Finishes and Moisture)

Scope: The scope of the Committee shall be the development of standards, promotion of knowledge, and stimulation of research pertaining to thermal insulation materials, products, systems, and associated coatings and coverings, but not including insulating refractories. These activities shall be coordinated with those of other ASTM Committees and national and international organizations having similar interest.

2.2.2 ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications (Subcommittee D01.23 on Physical Properties of Applied Paint Films)

Scope: Development of test methods, definitions, practices, specifications, classifications, guides, and related knowledge for:
(1) paint, varnish, lacquer, printing ink and other related coatings and materials in liquid, liquefiable, powder, or mastic form,
(2) components thereof,
(3) preparation of surfaces to which such coatings are applied
(4) coating-substrate systems, and
(5) paint application tools.

2.2.3 ASTM Committee E44. Subcommittee E44.09 on Photovoltaic Electric Power Conversion

Scope: The promotion of knowledge, stimulation of research and the development of standard test methods, specifications, guides, practices and terminology concerned with the technology for conversion of solar and geothermal renewable energy to directly usable energy forms and the application of such technology for the public benefit.

2.2.4 ASTM Committee F02 on Flexible Barrier Packaging (Subcommittee F02.10 on Permeation)

Scope: The development of terminology, test methods, practices, and specifications for flexible barrier packaging, and the promotion of research in this field. Standards under the jurisdiction of other committees shall be used when applicable.

The area of interest of the committee is flexible barrier packaging including the component barrier materials, their properties, and package design, development and production.

Flexible barrier packaging for the purpose of this Committee includes any package with at least one flexible component that can be bent or folded back upon itself.

Typical flexible barrier materials are papers, nonwovens, plastic films, and metal foils, used alone, treated or in various combinations.

2.2.5 CIE TC2 Physical Measurement of Light and Radiation

Scope: To study standard procedures for the evaluation of ultraviolet, visible and infrared radiation, global radiation, and optical properties of materials and luminaires. To study optical properties and performance of physical detectors and other devices required for their evaluation.

TC2-68 and TC2-75 are active on OLEDs.

2.2.6 IEC TC 110 Electronic display devices

Scope: Standardization, in the field of electronic display devices and specific relevant components, of terms and definitions, letter symbols, essential ratings and characteristics, measuring methods, specifications for quality assurance and related test methods, and reliability.

2.2.7 IEC TC 113 Nanotechnology standardization for electrical and electronic products and systems

Scope: Standardization of the technologies relevant to electrical and electronic products and systems in the field of nanotechnology in close cooperation with other committees of IEC and ISO TC 229.

2.2.8 IEC TC 119 Printed Electronics

Scope: Standardization of terminology, materials, processes, equipment, products and health/safety/environment in the field of printed electronics.

2.2.9 IEC TC 34 Lamps and related equipment / SC 34A Lamps

To prepare International Standards regarding specifications for lamps* and glow starters.

* The term Lamps includes LEDs for General Lighting Services

2.2.10 IEC TC 47 Semiconductor devices (overlaps with TC 82 and TC 119)

Scope: To prepare international standards for the design, manufacture, use and reuse of discrete semiconductor devices, integrated circuits, display devices, sensors, electronic component assemblies, interface requirements, and microelectromechanical devices, using environmentally sound practices. Activities include wafer level reliability, package outlines, terms and definitions, quality issues, physical environmental testing, device specific test methods, device specifications and minimum content, pinouts, interface requirements, and applications.

Excluded from the scope are:

- Systems of photovoltaic conversion and all the elements in the entire photovoltaic energy system (TC 82).

2.2.11 IEC TC 82 Solar photovoltaic energy systems

Scope: To prepare international standards for systems of photovoltaic conversion of solar energy into electrical energy and for all the elements in the entire photovoltaic energy system. In this context, the

concept "photovoltaic energy system" includes the entire field from light input to a photovoltaic cell to and including the interface with the electrical system(s) to which energy is supplied.

2.2.12 IEC TC 91 Electronics assembly technology

Scope: To prepare international standards on electronic assembly (relevant) technologies and in the field of printed board assemblies, including the requirements for materials used to manufacture printed boards, electronic and electromechanical component mounting and attachment, as well as the electronic data format for describing these products and processes.

2.2.13 IEEE 1620 Printed and Organic Electronics Working Group

Scope: To facilitate development of standards and to establish a knowledge management asset site for standards related activities in the organic, inorganic, and molecular electronics space.

2.2.14 IPC D-60 Printed Electronics Committee

Scope: Standardisation related to fundamental design considerations for printed electronics, base materials, functional additive materials applied to the surface of a substrate, processing of printed electronics, final printed electronics assembly and test method development and validation.

2.2.15 ISO/TC 6/SC 2 Test methods and quality specifications for paper and board

Scope: Standardisation related to pulp, paper and board products. Within this domain the main objectives and priorities are (1) to provide maintenance on existing standards, (2) to develop new standards for characterizing traditional products, (3) to develop new standards for typifying new products, (4) to ensure that the standards fulfil societal requirements with respect to health, environmental protection, material and product safety and quality, (5) to recognize the interests of all markets, thereby ensuring the global relevance of TC6 standards and facilitating international trade.

Includes one standard on water permeation measurements (gravimetric).

2.2.16 ISO/TC 61 Plastics

Scope: Standardisation of nomenclature, methods of test, and specifications applicable to materials and products in the field of plastics. The objective of TC 61 is the timely development and maintenance of quality, market relevant, material and semi-finished product test methods and standards for the global plastics industry.
Includes standards on mechanical properties, water vapour transmission rate (WVTR) and aging of plastic sheets. (Only WVTR documents are included in this report)

2.3 RELEVANT PRE-STANDARDISATION WORKING GROUPS

The groups listed below have been mainly involved in the development of common measurement protocols and validated procedures. Some of the outputs include interlaboratory studies, peer-reviewed papers and white papers. Those interested in joining the working groups should contact the respective group chair directly.

2.3.1 VAMAS TWA 36 Organic Electronics

Scope: VAMAS supports world trade in products dependent on advanced materials technologies, through collaborative projects aimed at providing the technical basis for harmonized measurements, testing, specifications, and standards. Activities of TWA36 include interlaboratory comparison studies of measurement methods as well as creation of agreed and validated measurement procedures for relevant properties. The focus is on pre-standardisation effort to feed into standardisation groups.

2.3.2 EERA JP-PV SUB-PROGRAMME 3: Hybrid and Organic Photovoltaics (HOPV)

Scope: One of the focuses of this sub-programme is to develop and validate protocols for screening of materials, define common protocols to test stability and define standards for test device architectures for both printed and lab fabricated devices. Activities include Round Robins and analysis of measurement protocols.

2.3.3 OE-A OEE

Scope: Currently the group is working on a White Paper on Organic Electronics Energy, the OE-A Roadmap and testing guidelines for OPV.

2.3.4 OE-A Encapsulation

Scope: The goal of the OE-A Working Group `Encapsulation´ is to trigger the standards development process. Therefore the group has initiated round robin tests to clarify permeation testing for qualification of sealant materials and barrier-on-foil materials using optical and electrical Calcium-Tests.

2.4 HOW TO OBTAIN TECHNOLOGY VERIFICATION WHEN STANDARDS ARE NOT YET AVAILABLE?

2.4.1 Environmental Technology Verification (ETV)

Standards and regulations can take a long time to catch up with cutting edge technology. Environmental Technology Verification (ETV) is a voluntary scheme that provides the verification, by qualified third party organisations, of the performance claims of new environmental technologies not covered by standards. This should help manufacturers prove the reliability of their claims to customers and investors.

ETV has been successfully implemented in the United States, China, Japan, Korea, Canada, the Philippines and the European Union. In 2007, an ETV International Working Group was formed to work on the convergence of the different programmes towards mutual recognition. A draft standard is currently under preparation by Working Group 5 - Environmental Technology Verification of the ISO Technical Committee 207 (Environmental Management), Sub-committee 4 (ISO/TC 207/SC 4/WG 5).

More information about the scheme can be found at the following websites:

European ETV pilot programme

Canadian Environmental Technology Verification programme

Korean New Excellent Technology (NET) & Environmental Technology Verification (ETV) Project

Philippine Environmental Technology Verification programme

US Environment Technology Verification programme

Japanese pilot project of Environmental Technology Verification

2.5 PUBLISHED STANDARDS / TECHNICAL REPORTS / TECHNICAL SPECIFICATIONS / TECHNICAL / PUBLICLY AVAILABLE SPECIFICATIONS

Documents listed in alphabetical order.

2.5.1 Nanomaterials (e.g. CNT, Graphene, Metal Inks) and Organic Semiconductors

- IEC 61249-5-4:1996 Materials for interconnection structures - Part 5: Sectional specification set for conductive foils and films with or without coatings - Section 4: Conductive inks

Details requirements for the qualification of conductive inks and for conductive inks intended for use as a substitute for metallic finishes on contacts.

- IEC/PAS 62565-2-1:2011(E) Nanomanufacturing - Material specifications - Part 2-1: Single-wall carbon nanotubes - Blank detail specification

Establishes a blank detail specification for the essential electrical properties and certain other common characteristics, including dimensional, structural and mechanical properties of single-wall carbon nanotubes. It provides a standardized format for detail specifications characterising essential basic properties of single-wall nanotubes and recommends measurement methods. Single-wall carbon nanotubes with a chemical modification, dispersed into a solvent or grown on a substrate are included.

- IEC/TS 62607-2-1:2012(E) Nanomanufacturing - Key control characteristics - Part 2-1: Carbon nanotube materials - Film resistance

Technical specification: provides a standardized method for categorizing a grade of commercial carbon nanotubes in terms of their electrical properties to enable a user to select a carbon nanotube material suitable for their application. The method is intended to assess whether the delivered materials from different production batches of the same production process are comparable regarding electrical properties of the final product that are related to electrical conductivity. The correlation between the measured parameters by the proposed method and a relevant product performance parameter has to be established for every application.

- IEC 62607-3-1:2014 Nanomanufacturing - Key control characteristics - Part 3-1: Luminescent nanomaterials - Quantum efficiency

Describes the procedures to be followed and precautions to be observed when performing reproducible measurements of the quantum efficiency of luminescent nanomaterials. Luminescent nanomaterials covered by this method include nano-objects such as quantum dots, nanophosphors, nanoparticles, nanofibers, nanocrystals, nanoplates, and structures containing these materials. The nanomaterials may be dispersed in either a liquid state (e.g., colloidal dispersion of quantum dots) or solid-state (e.g., nanofibers containing luminescent nanoparticles). This standard covers both relative measurements of liquid state luminescent nanomaterials and absolute measurements of both solid and liquid state nanomaterials.

- IEC TS 62607-5-1:2014(E) Nanomanufacturing - Key control characteristics - Part 5-1: Thin-film organic/nano electronic devices - Carrier transport measurements

Provides a standardised 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.

- IEC 62624:2009(E) (IEEE 1650:2005) Test methods for measurement of electrical properties of carbon nanotubes

Provides methods for the electrical characterization of carbon nanotubes (CNTs). The methods will be independent of processing routes used to fabricate the CNTs.

2.5.2 Organic Photovoltaics

The following standards are generic for photovoltaic devices and modules.

- ASTM E1021 - 12 Standard Test Method for Spectral Responsivity Measurements of Photovoltaic Devices

This test method is to be used to determine either the absolute or relative spectral responsivity response of a single-junction photovoltaic device. This is necessary for computing the spectral mismatch parameter that is used to correct further photovoltaic characterisation, such as the power conversion efficiency. The spectral responsivity of a photovoltaic device is useful for understanding device performance and material characteristics.

- ASTM E948-15 Standard Test Method for Electrical Performance of Photovoltaic Cells Using Reference Cells Under Simulated Sunlight

It is the intent of this test method to provide a recognized method for testing and reporting the electrical performance of photovoltaic cells. This test method covers the determination of the electrical performance of a photovoltaic cell under simulated sunlight by means of a calibrated reference cell procedure. Electrical performance measurements are reported with respect to a select set of standard reporting conditions (SRC) or to user-specified conditions. The SRC or user-specified conditions include the cell temperature, the total irradiance, and the reference spectral irradiance distribution. This test method is applicable only to photovoltaic cells with a linear response over the range of interest.

- ASTM E927 - 10 Standard Specification for Solar Simulation for Terrestrial Photovoltaic Testing

This specification provides the performance requirements and parameters used for classifying both pulsed and steady state solar simulators intended for indoor testing of photovoltaic devices (solar cells or modules), according to their spectral match to a reference spectral irradiance, non-uniformity of spatial irradiance, and temporal instability of irradiance. The classification of a solar simulator is based on the size of the test plane, and does not provide any information about electrical measurement errors that are related to photovoltaic performance measurements obtained with a classified solar simulator.

- ASTM E973 - 10 Standard Test Method for Determination of the Spectral Mismatch Parameter Between a Photovoltaic Device and a Photovoltaic Reference Cell

This test method covers a procedure for the determination of a spectral mismatch parameter used in performance testing of photovoltaic devices. The spectral mismatch parameter is a measure of the error, introduced in the testing of a photovoltaic device, caused by mismatch between the spectral responses of the photovoltaic device and the photovoltaic reference cell, as well as mismatch between the test light source and the reference spectral irradiance distribution to which the photovoltaic reference cell was calibrated.

- ASTM E1171-15 Standard Test Methods for Photovoltaic Modules in Cyclic Temperature and Humidity Environments

These test methods provide procedures for stressing photovoltaic modules in simulated temperature and humidity environments. Environmental testing is used to simulate aging of module materials on an accelerated basis. Three individual environmental test procedures are defined by these test methods: a thermal cycling procedure, a humidity-freeze cycling procedure, and an extended duration damp heat procedure. Electrical biasing is utilized during the thermal cycling procedure to simulate stresses that

are known to occur in field-deployed modules. These test methods define mounting methods for modules undergoing environmental testing, and specify parameters that must be recorded and reported. These test methods do not establish pass or fail levels. The determination of acceptable or unacceptable results is beyond the scope of these test methods. Any of the individual environmental tests may be performed singly, or may be combined into a test sequence with other environmental or non-environmental tests, or both. Certain pre-conditioning tests such as annealing or light soaking may also be necessary or desirable as part of such a sequence. The determination of any such sequencing and pre-conditioning is beyond the scope of this test method. These test procedures are limited in duration and therefore the results of these tests cannot be used to determine photovoltaic module lifetimes.

- ASTM E2236-10 Standard Test Methods for Measurement of Electrical Performance and Spectral Response of Non-concentrator Multijunction Photovoltaic Cells and Modules

These test methods provide special techniques needed to determine the electrical performance and spectral response of two-terminal, multijunction photovoltaic (PV) devices, both cell and modules. These test methods are modifications and extensions of the procedures for single-junction devices defined by Test Methods E948, E1021, and E1036. These test methods do not include temperature and irradiance corrections for spectral response and current-voltage (I-V) measurements. Procedures for such corrections are available in Test Methods E948, E1021, and E1036. These test methods may be applied to cells and modules intended for concentrator applications.

- IEC TS 61836:2007 Solar photovoltaic energy systems - Terms, definitions and symbols

Provides terms, definitions and symbols from national and international solar photovoltaic standards and relevant documents used within the field of solar photovoltaic (PV) energy systems. The main changes with respect to the previous edition are as follows: increased number of terms, inclusion of a list of abbreviations, organization of terms in categories and families.

- IEC 60904:2015 SER Photovoltaic devices - ALL PARTS

Describes tests for photovoltaic devices including IEC 60904 standard part 1 to part 10.

- IEC 60891 Edition 2.0 (2009-12-14) Photovoltaic devices - Procedures for temperature and irradiance corrections to measured I-V characteristics

Defines procedures to be followed for temperature and irradiance corrections to the measured I-V (current-voltage) characteristics of photovoltaic devices. It also defines the procedures used to determine factors relevant for these corrections.

- IEC 61730-1:2004+A1:2011+A2:2013 Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction

Describes the fundamental construction requirements for photovoltaic modules in order to provide safe electrical and mechanical operation during their expected lifetime. Addresses the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses.

- IEC 61730-2:2004+A1:2011 Photovoltaic (PV) module safety qualification - Part 2: Requirements for testing

Describes the testing requirements for photovoltaic modules in order to provide safe electrical and mechanical operation during their expected lifetime. Addresses the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses.

- IEC 61701:2011 Salt mist corrosion testing of photovoltaic (PV) modules

Describes test sequences useful to determine the resistance of different PV modules to corrosion from salt mist containing Cl- (NaCl, MgCl2, etc.). All tests included in the sequences, except the bypass diode functionality test, are fully described in IEC 61215, IEC 61646, IEC 62108, IEC 61730-2 and IEC 60068-2-52. This Standard can be applied to both flat plate PV modules and concentrator PV modules and assemblies. Salt mist test is based on IEC 60068-2-52 rather than IEC 60068-2-11 as in edition 1 since

the former standard is much more widely used in the electronic component field. According to this change the new edition 2 includes a cycling testing sequence that combines in each cycle a salt fog exposure followed by humidity storage under controlled temperature and relative humidity conditions. This testing sequence is more suitable to reflect the corrosion processes that happen in PV modules subjected to permanent or temporary corrosive atmospheres.

- IEC 61345:1998 UV test for photovoltaic (PV) modules

Determines the ability of a photovoltaic module to withstand exposure to ultra-violet (UV) radiation from 280 nm to 400 nm.

- IEC 61853-1:2011 Photovoltaic (PV) module performance testing and energy rating - Part 1: Irradiance and temperature performance measurements and power rating

IEC 61853-1:2011 describes requirements for evaluating PV module performance in terms of power (watts) rating over a range of irradiances and temperatures. The object is to define a testing and rating system, which provides the PV module power (watts) at maximum power operation for a set of defined conditions. A second purpose is to provide a full set of characterization parameters for the module under various values of irradiance and temperature.

2.5.3 Organic Light Emitting Diodes (including OLED Displays)

- ANSI/UL 8752 OLED panels

These requirements apply to organic lighting emitting diode (OLED) panels intended for task, ambient, or aesthetic illumination, and for portable or permanent installation in accordance with the following standards, and for connection to isolated (non-utility connected) power sources such as generators, batteries, fuel cells, solar cells, and the like.

- IEC 62341-1-1:2009 Organic light emitting diode (OLED) displays - Part 1-1: Generic specifications

Generic specification for organic light emitting diode (OLED) displays. It defines general procedures for quality assessment to be used in the IECQ System and establishes general rules for methods of electrical and optical measurements, environmental and mechanical tests and endurance tests.

- IEC 62341-1-2:2014 Organic light emitting diode (OLED) displays - Part 1-2: Terminology and letter symbols

IEC 62341-1-2:2014 gives the preferred terms, their definitions and symbols for organic light emitting diode (OLED) displays, with the object of using the same terminology when publications are prepared in different countries.

- IEC 62341-5:2009 Organic light emitting diode (OLED) displays - Part 5: Environmental testing methods

Defines testing methods for evaluating environmental endurance of organic light emitting diode display modules (OLED display modules) for use and storage under the assumed usage environment.

- IEC 62341-5-2:2013 Organic light emitting diode (OLED) displays - Part 5-2: Mechanical endurance testing methods

Defines testing methods for evaluating mechanical endurance quality of Organic Light Emitting Diode (OLED) display panels and modules or their packaged form for transportation. It takes into account, wherever possible, the environmental testing methods outlined in specific parts of IEC 60068. The object of this standard is to establish uniform preferred test methods for judging the mechanical endurance properties of OLED display devices.

- IEC 62341-5-3:2013 Organic light emitting diode (OLED) displays - Part 5-3: Measuring methods of image sticking and lifetime

Specifies the standard measurement conditions and measurement methods for determining the image sticking and lifetime of organic light emitting diode (OLED) display panels and modules. It mainly applies to modules.

- IEC 62341-6-1:2009 Organic light emitting diode (OLED) displays - Part 6-1: Measuring methods of optical and electro-optical parameters

Specifies the standard measurement conditions and measuring methods for determining optical and electro-optical parameters of organic light emitting diode (OLED) display modules, and where specified, OLED display panels, in the following areas: a) luminance and uniformity; b) dark room contrast ratio; c) chromaticity, colour uniformity, colour gamut and white field correlated colour temperature; d) power consumption.

- IEC 62341-6-2:2012 Organic light emitting diode (OLED) displays - Part 6-2: Measuring methods of visual quality and ambient performance

Specifies the standard measurement conditions and measurement methods for determining the visual quality and ambient performance of organic light-emitting diode (OLED) display modules and panels. This document mainly applies to colour display modules.

- IEC 62341-6-3:2012 Organic light emitting diode (OLED) displays - Part 6-3: Measuring methods of image quality

Specifies the standard measurement conditions and measuring methods for determining image quality of organic light emitting diode (OLED) display panels and modules. More specifically, this standard focuses on five specific aspects of image quality, i.e., the viewing angle range, cross-talk, flicker, static image resolution, and moving image resolution.

- IEC 62868 ed1.0 Organic light emitting diode (OLED) panels for general lighting - Safety requirements

IEC 62868:2014 specifies the safety requirements of OLED tiles and panels for use on d.c. supplies up to 120 V or a.c. supplies up to 50 V at 50 Hz or 60 Hz for indoor and similar general lighting purposes.

For OLED lighting, general lighting standards are being used, such as:

- IEC 60598-1 Luminaires
- IEC 62031 LED modules for general lighting
- IEC 62471 Photobiological safety of lamps and lamp systems
- IES-LM-79-08 Electrical and Photometric Measurements of Solid-State Lighting

2.5.4 Thin Film Transistors

- IEC/IEEE 62860:2013(E) Test methods for the characterization of organic transistors and materials

Covers recommended methods and standardized reporting practices for electrical characterization of printed and organic transistors. Due to the nature of printed and organic electronics, significant measurement errors can be introduced if the electrical characterization design-of-experiment is not properly addressed. This standard describes the most common sources of measurement error, particularly for high-impedance electrical measurements commonly required for printed and organic transistors. This standard also gives recommended practices in order to minimize and/or characterize the effect of measurement artefacts and other sources of error encountered while measuring printed and organic transistors.

- IEC 62860-1:2013(E) / IEEE Std 1620.1™-2006 Test methods for the characterization of organic transistor-based ring oscillators

Covers recommended methods and standardized reporting practices for electrical characterization of printed and organic ring oscillators. Due to the nature of printed and organic circuits, significant measurement errors can be introduced if the electrical characterization design-of-experiment is not properly addressed. This standard describes the most common sources of measurement error, particularly for high-impedance electrical measurements commonly required for printed and organic ring oscillators. This standard also gives recommended practices in order to minimize and/or characterize the effect of measurement artefacts and other sources of error encountered while measuring printed and organic ring oscillators.

2.5.5 Displays (not including OLED Displays)

- IEC 62679-1-1:2014 Electronic paper displays - Part 1-1: Terminology

Gives the preferred terms, their definitions, as well as the symbols for electronic paper displays (EPDs).

- IEC 62679-3-1:2014 Electronic paper displays - Part 3-1: Optical measuring methods

Specifies the standard measurement conditions and measurement methods for determining the optical performance of Electronic Paper Display (EPDs). The scope of this document is restricted to EPDs using either segment, passive, or active matrix with either monochromatic or colour type displays. The measuring methods are intended for EPDs operated in a reflective mode. The EPDs may include an integrated lighting unit (ILU), but the ILU will be turned off for these measuring methods. Colour systems beyond three primaries are not covered in this document.

- IEC 62679-3-2:2013 Electronic paper display - Part 3-2: Measuring method - Electro-optical

Is restricted to electronic paper display modules using either segment, passive, or active matrix, and either monochromatic, or colour type displays. In order to achieve a useful and uniform description of the performance of these devices, specifications for commonly accepted relevant parameters are put forward. The purpose of IEC 62679-3-2 is to indicate and list the procedure-dependent parameters and to prescribe the specific methods and conditions that are to be used for their uniform numerical determination.

2.5.6 Other Flexible Electronic Applications (e.g. Batteries, Smart Cards…)

There are none yet.

2.5.7 Substrates and Encapsulants (including Barrier Layers)

- ASTM D1653 – 13 Standard Test Methods for Water Vapour Transmission of Organic Coating Films

Describes two test methods to determine the water vapour transmission rate through films of paint, varnish, lacquer, and other organic coatings. The films may be free films or they may be applied to porous substrates.

Test Method A—The Dry Cup Method is the preferred test method for obtaining values that relate to conventional dwellings where high relative humidities are not anticipated.

Test Method B—The Wet Cup Method is the preferred test method for obtaining values that relate to applications where high relative humidities are anticipated in the vicinity of the barrier material. In

general, the more permeable a coating is to the passage of moisture as is typical of many water-reducible coatings, the greater its affinity for water and the greater the increase in transmission when tested in and exposed to high humidity. Absorption of water may make a coating less dense, thus allowing moisture to diffuse easily and cause a much higher moisture vapour transmission rate, (WVTR) than would occur in drier environments.

- ASTM E96 / E96M - 14 Standard Test Methods for Water Vapour Transmission of Materials

These test methods cover the determination of water vapour transmission (WVT) of materials through which the passage of water vapour may be of importance, such as paper, plastic films, other sheet materials, fibreboards, gypsum and plaster products, wood products, and plastics. The test methods are limited to specimens not over 1 1/4 in. [32 mm] in thickness except as provided in Section 9. Two basic methods, the Desiccant Method and the Water Method, are provided for the measurement of permeance, and two variations include service conditions with one side wetted and service conditions with low humidity on one side and high humidity on the other. Agreement should not be expected between results obtained by different methods. The method should be selected that more nearly approaches the conditions of use.

- ASTM E398 - 13 Standard Test Method for Water Vapour Transmission Rate of Sheet Materials Using Dynamic Relative Humidity Measurement

This test method covers dynamic evaluation of the rate of transfer of water vapour through a flexible barrier material and allows conversion to the generally recognized units of water vapour transmission (WVT) as obtained by various other test methods including the gravimetric method described in Test Methods E 96/E 96M. This test method is limited to flexible barrier sheet materials composed of either completely hydrophobic materials, or combinations of hydrophobic and hydrophilic materials having at least one surface that is hydrophobic.

The minimum test value obtained by this test method is limited by the leakage of water vapour past the clamping seals of the test instrument. A reasonable value may be approximately 0.01 g/24 h•m^2 for any WVTR method including the desiccant procedure of Test Methods E 96/E 96M at 37.8 °C, and 90 % relative humidity. This limit can be checked for each instrument with an impervious specimen such as aluminium foil. Calibration procedures can compensate for the leakage rate if so stated.

- ASTM F1249 - 13 Standard Test Method for Water Vapour Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor

This test method covers a procedure for determining the rate of water vapour transmission through flexible barrier materials. The method is applicable to sheets and films up to 3 mm (0.1 in.) in thickness, consisting of single or multilayer synthetic or natural polymers and foils, including coated materials. It provides for the determination of (1) water vapour transmission rate (WVTR), (2) the permeance of the film to water vapour, and (3) for homogeneous materials, water vapour permeability coefficient.

- ISO 2528 Sheet materials -- Determination of water vapour transmission rate -- Gravimetric (dish) method

Specifies a method for the determination of the water vapour transmission rate of sheet materials. Not applicable to film materials that are damaged by hot wax or that shrink under the test conditions.

- ISO 15105-1:2007 Plastics -- Film and sheeting -- Determination of gas-transmission rate -- Part 1: Differential-pressure methods

ISO 15105-1:2007 specifies two methods for determining the gas transmission rate of single-layer plastic film or sheet and multi-layer structures under a differential pressure. One method uses a pressure sensor, the other a gas chromatograph, to measure the amount of gas which permeates through a test specimen.

- ISO 15105-2:2003 Plastics -- Film and sheeting -- Determination of gas-transmission rate -- Part 2: Equal-pressure method

ISO 15105-2:2003 specifies a method for the determination of the gas-transmission rate of any plastic material in the form of film, sheeting, laminate, co-extruded material or flexible plastic-coated material. Specific examples, currently in use, of the method are described in the annexes.

- ISO 15106-1:2003 Plastics -- Film and sheeting -- Determination of water vapour transmission rate -- Part 1: Humidity detection sensor method

ISO 15106-1:2003 specifies an instrumental method for determining the water vapour transmission rate of plastic film, plastic sheeting and multi-layer structures including plastics, using a humidity detection sensor. The method provides rapid measurement over a wide range of water vapour transmission rates.

- ISO 15106-2 Plastics -- Film and sheeting -- Determination of water vapour transmission rate -- Part 2: Infrared detection sensor method

ISO 15106-2:2003 specifies an instrumental method for determining the water vapour transmission rate of plastic film, plastic sheeting and multi-layer structures including plastics, using an infrared detection sensor.

- ISO 15106-3:2003 Plastics -- Film and sheeting -- Determination of water vapour transmission rate -- Part 3: Electrolytic detection sensor method

ISO 15106-3:2003 specifies an instrumental method for determining the water vapour transmission rate of plastic film, plastic sheeting and multi-layer structures including plastics, using an electrolytic detection sensor. The method provides rapid measurement over a wide range of water vapour transmission rates.

- ISO 15106-4:2008 Plastics -- Film and sheeting -- Determination of water vapour transmission rate -- Part 4: Gas-chromatographic detection sensor method

ISO 15106-4:2008 specifies an instrumental method for determining the water vapour transmission rate of single-layer plastic film and sheet, as well as multi-layer structures including plastics, using a gas chromatograph. The method provides rapid measurement over a wide range of water vapour transmission rates.

2.5.8 Processing / Manufacturing

There are none yet.

2.5.9 Generic for Printed Electronics and Other Topics not yet covered

- IPC/JPCA-2291, Design guideline for printed electronics (2013)

This guideline provides an overview of the design process flow for printed electronics based devices, modules and units, and final products. The intent of IPC/JPCA-2291 is to establish a design process flow that will facilitate and improve the practice of printed electronics design. IPC/JPCA-2291 identifies documents such as standards that can be used to assist during the design process flow.

- IPC/JPCA-4921, Requirements for printed electronics base materials (2012)

This document provides comprehensive data to help users more easily determine both material capability and compatibility for flexible and rigid base dielectric materials for manufacture of printed electronics. It includes base material specification sheets that have been updated with the newest properties for the specification material types. It establishes the most current classification system, qualification and quality conformance requirements, including those raw material properties of particular interest to the printed electronics designer, fabricator, or user.

- IPC/JPCA-4591, Requirements for printed electronics functional conductive materials (2012)

This document provides comprehensive data to help users more easily determine material performance, capabilities, and compatibility of functional conductive materials for the manufacture of printed electronics. It includes: classification schemes based on composition, conductor type, and post-processing structure; functional conductive material specification sheets to present properties for the different conductive material types; and the most current classification system, qualification and quality conformance requirements, including those raw material properties of particular interest to the printed electronics designer, fabricator, or other user.

- IEC/TR 62834:2013(E) IEC nanoelectronics standardization roadmap

A technical report that describes the "IEC nanoelectronics standardization roadmap". It intends to establish a common standardization strategy in the area of nano-electrotechnology. It covers the standardization plan from 2009 to 2020 for nanomaterials, nanoscale devices, and nanofabrication processes. The report starts with a situation assessment of the market, the actual technology status, and future evolution. It provides later the list of potential standards to be developed within the concerned timeframe. The goal of this technical report is to build a consensus among members of the nano-electrotechnology community on a framework leading to inputs for consideration in standards development.

- IEC 62715-1-1:2013 Flexible display devices - Part 1-1: Terminology and letter symbols

Gives the preferred terms, their definitions and symbols for flexible display devices, with the object of using the same terminology when standards are prepared in different countries.

- IEC 62715-6-1:2014 Flexible display devices - Part 6-1: Mechanical stress test methods

Defines the standard test methods to evaluate the mechanical stability of flexible display modules which include displays such as LCD, e-paper, and OLED. It takes into account, wherever possible, the mechanical test methods outlined under mechanical stress.

- IEC 60749-7:2011 Edition 2.0 Semiconductor devices - Mechanical and climatic test methods - Part 7: Internal moisture content measurement and the analysis of other residual gases

IEC 60749-7:2011 specifies the testing and measurement of water vapour and other gas content of the atmosphere inside a metal or ceramic hermetically sealed device. The test is used as a measure of the quality of the sealing process and to provide information about the long-term chemical stability of the atmosphere inside the package. It is applicable to semiconductor devices sealed in such a manner but generally only used for high reliability applications such as military or aerospace. This test is destructive. This second edition cancels and replaces the first edition published in 2002 and constitutes a technical revision. This second edition has been completely re-written so as to align it with the text of the latest versions of MIL-STD-750, method 1018 and MIL-STD-883, method 1018. The main change is the removal of the two alternative methods formerly designated method 2 and method 3.

- ISO/TS 80004-3:2010 Nanotechnologies - Vocabulary - Part 3: Carbon nano-objects

Lists terms and definitions related to carbon nano-objects in the field of nanotechnologies. It is intended to facilitate communications between organizations and individuals in industry and those who interact with them.

2.6 PUBLISHED PRE-STANDARDISATION DOCUMENTS (WHITE PAPERS, PROTOCOLS, ROUND ROBINS)

- Efficient Electrical End-Use Equipment (4E) International Energy Agency SSL Annex Task 2 report “Solid State Lighting Annex: Interlaboratory Comparison Test Method”

This document covers test methods for measurements of electrical, photometric, and colorimetric quantities of LED lamps and LED luminaires that are covered in IEA 4E SSL Annex Interlaboratory Comparisons, which deal only with complete solid state lighting products (LED lamps and LED luminaires) that require AC mains power or a DC voltage power in branch circuit to operate. Non-integrated LED lamps (including tubular LED lamp) and luminaires with a separate LED driver (physically separate from the lamp or the luminaire) are also covered in this document if its driver is sold together or clearly specified by the product specification. LED light engines, LED modules and LED packages are not covered in this document. Testing of the lifetime of the products is not covered.

- OLLA White paper on OLED luminous efficacy measurement standardisation (IST-004607 OLLA)
- Consensus stability testing protocols for organic photovoltaic materials and devices, Reese *et. al.*, Solar Energy Materials and Solar Cells 95 (2011) 1253–1267.

This publication describes a series of tests (also known as ISOS tests) being used to assess lifetime of organic photovoltaic solar cells and modules. The tests are divided in classes that include: dark, outdoor, lab weathering, thermal cycling, solar-thermal-humidity. These are not officially standards but are considered to be guidance protocols to facilitate comparison of results. There are several other published papers that use or test the reliability of these ISOS tests.

- Worldwide outdoor round robin study of organic photovoltaic devices and modules, M.V. Madsen et al Solar Energy Materials and Solar Cells 130 (2014) 281-290.
- Round robin performance testing of organic photovoltaic devices, S.A. Gevorgyan et al Renewable Energy 63 (2014) 376-387.
- A critical look at organic photovoltaic fabrication methodology: Defining performance enhancement parameters relative to active area, L.J. Rozanski et al. Solar Energy Materials and Solar Cells 130 (2014) 513-520.
- Thermal effects on optical measurement of the OLED lighting, M. Hirasawa and Y. Yamauchi, CIE 2012, (2012) 643-646.
- Towards reliable charge-mobility benchmark measurements for organic semiconductors, J. Blakesley et al., Organic Electronics 15 (2015) 1263-1272.
- Protocol for data analysis and reporting of space charge limited current charge mobility measurements of organic semiconductors.

2.7 UPCOMING STANDARDS / TECHNICAL REPORTS / TECHNICAL SPECIFICATIONS / TECHNICAL / PUBLICLY AVAILABLE SPECIFICATIONS

Reference to documents start with the name of the standardisation technical committee (listed in alphabetical order).

2.7.1 Nanomaterials (e.g. CNT, Graphene, Metal Inks) and Organic Semiconductors

- IEC TC 113 - PWI/TR 62565-1 Ed. 1.0 Nanomanufacturing - Material specifications, Part 1 - Basic concept
- IEC TC 113 - IEC 62565-3-1 Ed. 1.0 Nanomanufacturing - Material specifications - Part 3-1: Graphene - Blank detail specification
- IEC TC 113 - IEC/TS 62607-3-2 Ed. 1.0 Nanomanufacturing - Key control characteristics - Part 3-2: Luminescent nanoparticles - Determination of mass of quantum dot dispersion
- IEC TC 113 - ISO/TR 19733 Ed. 1.0 Matrix of characterization and measurement methods for Graphene
- IEC TC 113 - PNW/TS 113-218 Ed. 1.0 ISO/IEC TS 80004-13: Nanotechnologies - Vocabulary - Part 13: Graphene and other two dimensional materials
- IEC TC 113 - PNW/TS 113-248 Ed. 1.0 IEC TS 62607-6-4: Nanomanufacturing - Key control characteristics - Part 6-4: Graphene - Non-contact conductance measurement using resonant cavity

- IEC TC 113 - PNW/TS 113-251 Ed. 1.0 IEC 62607-6-3: Nanomanufacturing - Key control characteristics - Part 6-3: Graphene - Evaluation of the defect level in the graphene layer
- IEC TC 113 - PWI 113-75 Ed. 1.0 IEC 62607-6-1: Nanomanufacturing - Key control characteristics - Part 6-1: Graphene - Electrical characterization
- IEC TC 113 - PWI 113-76 Ed. 1.0 IEC 62607-6-2: Nanomanufacturing - Key control characteristics - Part 6-2: Graphene - Evaluation of the number of layers of graphene
- IEC TC 113 - PWI 113-80 Ed. 1.0 IEC 62565-5-2: Nanomanufacturing - Material specifications - Part 5-2: Silver nanomaterials - Detail specification for nano-ink
- IEC TC 113 - PWI 113-81 Ed. 1.0 IEC TS 62607-2-4: Nanomanufacturing - Key control characteristics - Part 2-4: Carbon nanotube materials - Accuracy and repeatability of test methods for determination of resistance of carbon nanotubes
- IEC TC 113 - PWI 113-84 Ed. 1.0 IEC TS 62607-5-2: Nanomanufacturing - Key control characteristics - Part 5-2: Thin-film organic/nano electronics - Measurement of alternating current characteristics
- IEC TC 113 - PWI 62607-2-2 Ed. 1.0 PWI on IEC/TS 62607-2-2: Nanomanufacturing - Key control characteristics - Part 2-2: Carbon nanotube materials - Electro-magnetic compatibility
- IEC TC 113 - PWI/TS 113-72 Ed. 1.0 IEC/TS 62565-3-2: Nanomanufacturing - Material specifications - Part 3-2: Graphene - Detail specification for nano-ink
- IEC TC 119 - IEC 62899-2-1 Ed. 1.0 Printing electronics - Materials - Part 2-1: Conductive Material Ink
- IEC TC 119 - PNW 119-54 Ed. 1.0 Semiconductor ink

2.7.2 Organic Photovoltaics

- ASTM E44.09 - WK38365 New Test Methods for Ultraviolet Conditioning of Photovoltaic Modules or Mini-Modules Using a Fluorescent Ultraviolet (UV) Lamp Apparatus
- IEC TC 113 - IEC/TS 62876-2-1 Ed. 1.0 Nanotechnology - Reliability assessment - Part 2.1: Nano-enabled photovoltaic - Stability test
- IEC TC 113 - PWI 113-78 Ed. 1.0 IEC 62607-7-1: Nanomanufacturing - Key control characteristics - Part 7-1: Nano-enabled photovoltaics measurement of the electrical performance and spectral response of tandem cells
- IEC TC 82 - IEC 60904-1 Ed. 3.0 Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics
- IEC TC 82 - IEC 60904-1-1 Ed. 1.0 Photovoltaic devices - Part 1-1: Measurement of current-voltage characteristics of multi-junction photovoltaic devices
- IEC TC 82 - IEC 60904-7 Ed. 4.0 Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices
- IEC TC 82 - IEC 60904-8-1 Ed. 1.0 Photovoltaic devices - Part 8-1: Measurement of spectral responsivity of multi-junction photovoltaic (PV) devices
- IEC TC 82 - IEC 61853-2 Ed. 1.0 Photovoltaic (PV) modules performance testing and energy rating - Part 2: Spectral response, incidence angle and module operating temperature measurements
- IEC TC 82 - IEC 62805-1 Ed. 1.0 Test method for total haze and spectral distribution of haze of transparent conductive coated glass for solar cells
- IEC TC 82 - IEC 62805-2 Ed. 1.0 Test method for transmittance and reflectance of transparent conductive coated glass for solar cells
- IEC TC 82 - IEC 62892-1 Ed. 1.0 Comparative testing of PV modules to differentiate performance in multiple climates and applications - Part 1: Overall test sequence and method of communication
- IEC TC 82 - IEC 62788-1-4 Ed. 1.0 Measurement procedures for materials used in Photovoltaic Modules - Part 1-4: Encapsulants - Measurement of optical transmittance and calculation of the solar-weighted photon transmittance, yellowness index, and UV cut-off frequency

2.7.3 Organic Light Emitting Diodes (including OLED displays)

- CIE TC 2-68: Optical Measurement Methods for OLEDs used for Lighting. Technical Report on the measurement methods of the optical properties and the terminology of OLEDs used for lighting.
- CIE TC 2-75: Photometry of Curved and Flexible OLED and LED Sources Scope. CIE recommendation on methods for characterization of the photometric and colorimetric quantities of curved and flexible sources especially for OLED and LED including traceability.
- IEC TC 110 - IEC 62341-2-1 Ed. 1.0 Organic light emitting diode (OLED) displays - Part 2-1: Essential ratings and characteristics of OLED display modules
- IEC TC 110 - IEC 62341-6-1 Ed. 2.0 Organic light emitting diode (OLED) displays - Part 6-1: Measuring methods of optical and electro-optical parameters
- IEC TC 110 - IEC 62341-6-2 Ed. 2.0 Organic light emitting diode (OLED) displays - Part 6-2: Measuring methods of visual quality and ambient performance
- IEC TC 110 - IEC 62341-6-3 Ed. 2.0 Organic light emitting diode (OLED) displays - Part 6-3: Measuring methods of image quality
- IEC TC 110 - IEC 62341-6-4 Ed. 1.0 Organic light emitting diode (OLED) displays - Part 6-4: Measuring methods of transparent properties
- IEC TC 119 - IEC 62946-2 Ed. 1.0 Printed electronics - Quality assessment - Part x: Mechanical stress on printed OLED lighting devices formed on flexible substrates
- IEC TC 119 - PNW 119-40 Ed. 1.0 Printed electronics - Quality assessment - Part x: Mechanical stress on printed OLED lighting devices formed on flexible substrates
- IEC TC 34/SC 34A - IEC 62922 Ed. 1.0 Organic light emitting diode (OLED) panels for general lighting - Performance requirements
- IEC TC 34/SC 34A - IEC/TS 62972 Ed. 1.0 General lighting - Organic light emitting diode (OLED) products and related equipment - Terms and definitions

2.7.4 Thin Film Transistors

- IEC TC119 - PWI 119-1 Ed. 1.0 Organic and flexible TFT assessment
- P1620.1 IEEE Draft Standard for Test Methods for the Characterization of Organic Transistor Based Ring Oscillators

2.7.5 Displays (not including OLED Displays)

- IEC TC 110 - PNW 110-574 Ed. 1.0 Future IEC/TS 62715-X-X: Flexible display devices - Part X-X: Measuring methods of optical characteristics for curved displays
- IEC TC 110 - IEC 62679-3-3 Ed. 1.0 Electronic Paper Displays - Part 3-3: Optical measuring methods with integrated lighting unit
- IEC TC 110 - IEC 62679-4-2 Ed. 1.0 Electronic paper displays - Part 4-2: Environmental test method
- IEC TC 110 - IEC 62715-5-1 Ed. 1.0 Flexible display devices - Part 5-1: Measuring methods of optical performance
- IEC TC 110 - IEC 62715-5-3 Ed. 1.0 Flexible display devices - Part 5-3: Visual assessment
- IEC TC 110 - IEC 62715-6-2 Ed. 1.0 Flexible display devices - Part 6-2: Environmental testing methods
- IEC TC 110 - IEC 62908-1-2 Ed. 1.0 Touch and interactive displays - Part 1-2: Generic - Terminology and letter symbols
- IEC TC 110 - IEC 62908-12-10 Ed. 1.0 Touch and interactive displays - Part 12-10: Measurement methods of touch displays - Touch and electrical performance
- IEC TC 110 - IEC 62908-13-10 Ed. 1.0 Touch and interactive displays - Part 13-10: Environmental durability test methods

- IEC TC 110 - IEC/TR 62679-5-1 Ed. 1.0 Electronic paper displays -Part 5-1: Legibility of EPD in spatial frequency
- IEC TC 110 - IEC/TR 62977-3-2 Ed. 1.0 Electronic display devices - Part 3-2: Evaluation of optical characteristics - Mura
- IEC TC 110 - IEC/TS 62715-5-2 Ed. 1.0 Flexible display devices - Part 5-2: Measuring methods of optical characteristics for curved displays

2.7.6 Other Flexible Electronics Applications (e.g. Battery, Smart Cards)

- IEC TC 119 - IEC 62946-1 Ed. 1.0 Quality assessment in printed electronics - Part x: Flexible and/or bendable primary or secondary cells: Failure modes and mechanical testing
- IEC TC 119 - PWI 119-2 Ed. 1.0 Smart Cards

2.7.7 Substrates and Encapsulants (including Barrier Layers)

- IEC TC 119 - IEC 62899-1 Ed. 1.0 Printed electronics - Materials - Part 1 : Substrates
- ISO TC 61/SC 11 - ISO/DIS 15106-5 Plastics -- Film and sheeting -- Determination of water vapour transmission rate -- Part 5: Pressure sensor method
- ISO TC 61/SC 11 - ISO/DIS 15106-6 Plastics -- Film and sheeting -- Determination of water vapour transmission rate -- Part 6: Atmospheric pressure ionization mass spectrometer method
- ISO TC 61/SC 11 - ISO/DIS 15106-7 Plastics -- Film and sheeting -- Determination of water vapour transmission rate -- Part 7: Calcium corrosion method

2.7.8 Processing / Manufacturing

- IEC TC 113 - IEC/IEEE 62659 Ed. 1.0 Nanomanufacturing - Large scale manufacturing for nanoelectronics
- IEC TC 113 - IEC/TS 62565-4-2 Ed. 1.0 Nanomanufacturing - Material specifications - Part 4-2: Luminescent nanomaterials - Detail specification for general lighting and display applications
- IEC TC 119 - IEC 62902 Ed. 1.0 Printed electronics - Printability - Measurement of qualities - Part 2-1: Pattern width
- IEC TC 119 - IEC 62903-1 Ed. 1.0 Printed electronics - Equipment - Contact printing - Rigid master - Measurement method of plate master external dimension
- IEC TC 119 - IEC 62903-2 Ed. 1.0 Equipment - General - Contact printing - Rigid master - Part 2 - Measurement method of plate master pattern dimension
- IEC TC 119 - IEC 62904 Ed. 1.0 Printed electronics - Equipment - Inkjet - Measurement method of jetting speed
- IEC TC 119 - PNW 119-53 Ed. 1.0 Printed Electronics - Printability - Part 1 : Guideline

2.7.9 Generic for Printed Electronics and Other Topics not yet covered

- IEC TC 113 - IEC/TS 62607-4-3 Ed. 1.0 Nanomanufacturing - Key control characteristics - Part 4-3: Nano-enabled energy storage - Contact and coating resistivity measurements for nanomaterials
- IEC TC 113 - IEC/TS 62844 Ed. 1.0 Guidelines for quality and risk assessment for nano-enabled electrotechnical products
- IEC TC 119 - IEC 62905 Ed. 1.0 Printed Electronics – Vocabulary
- IEC TC 47 - IEC 62951-1 Ed. 1.0 Semiconductor devices - Flexible and stretchable semiconductor devices - Part 1: Bending test method for conductive thin films on flexible substrates

- IEC TC 91 - IEC 61189-3-913 Ed. 1.0 Test methods for electrical materials, printed boards and other interconnection structures and assemblies - Part 3-913: Test method for thermal conductivity of electronic circuit board for high-brightness LEDs
- IEEE 1620 - P1620.2 IEEE Draft Standard Methods for the Characterization of Printed and Organic Diode Bridge Structures for RF Devices
- IPC D-64 Draft document (IPC-6901), Performance Requirements for Printed Electronics Assemblies

3 ACRONYMS

AC	Alternating Current
ANSI	American National Standards Institute
CIE	Commission internationale de l'éclairage (International Commission on Illumination)
DC	Direct Current
DIS	Draft International Standard
EERA	European Energy Research Alliance
ETV	Environmental Technology Verification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
JP-PV	Joint Programme on Photovoltaics
JPCA	Japan Electronics Packaging and Circuits Association
IS	International Standard
ISO	International Organization for Standardization
ISOS	Name used for stability test protocols developed during the International Summit on OPV stability (ISOS). Not to be confused with ISO.
OE-A	Organic Electronics Association
OEE	Organic Electronics Energy
OLED	Organic Light Emitting Diode
OPV	Organic Photovoltaics
OTFT	Organic Thin Film Transistor
PAS	Publicly Available Specification
PNW	Proposed New Work
PWI	Proposed Work Item
RF	Radio Frequency
TC	Technical Committee
TR	Technical Report
TS	Technical Specification
UL	Underwriters Laboratories
VAMAS	Versailles Project on Advanced Materials and Standards
WVTR	Water vapour transmission rate

4 DISCLAIMER

This document does not intend to completely cover all aspects of standardisation for organic and printed electronics and in that respect will focus on some areas more than others. Most topics related to complete products; product components (e.g. inverters, cables…) and safety are not covered in this document.

The information in this report is based on public knowledge at the time of writing. In particular the number of items published or under development by different working groups will constantly change. Additionally not all documents published by all working groups are listed here as relevant to organic electronics; therefore the heat-map must be viewed as a guide only. Since the term “relevant” is subjective it is expected that different parties may have differing views about which documents should be excluded.

The international community is invited to send criticism/suggestions that will be taken into account when publishing a revised version of this document.