

Overview of Standardization Activities for Inkjet Additive Manufacturing (within IEC TC 119 Printed Electronics)

Kei Hyodo, Shinri Sakai; Yamagata Univ., Yonezawa-shi, Yamagata/Japan

Abstract

Until recently, Inkjet printing technologies are relatively isolated industry especially for conventional printing. Thus, there was no need to have any standardized evaluation methods for those technologies. However, rise of additive manufacturing and expansion of printed electronics are changing that. Especially, rapid expansion of inkjet printing application in printed electronics requests industries to have standard evaluation methods of that printing. As an International Standardization Organization for Printed Electronics, IEC TC 119 answers that request.

Introduction

In order to realize 'Printed Electronics' technologies for industrial use, IEC, International Electrotechnical Commission, established new TC, Technical Committee, called TC 119, Printed Electronics, in November 2011. In April, 2012, IEC TC 119 had its 1st plenary meeting, general assembly, at Seoul, Korea. We, IEC TC 119, officially started our activities of standardization in the field of printed electronics at that point.

IEC TC 119, Printed Electronics

The scope of IEC TC 119 is "Standardization of terminology, materials, processes, equipment, products and health/safety/environment in the field of printed electronics." IEC TC 119 is managed as shown in Table 1.

Table 1: IEC TC 119, Printed Electronics, management team

Chair person	Mr. Alan Hodgson (GB)
Secretary	Mr. Kyung-Tae Kang (KR)
Assistant Secretary	Mr. An-Jung Chung (KR) Mr. Joon-Shik Park (KR)

Under their management, we have several group called WG, Working Groups, as shown in Table 2 for specific area of printed electronics. The leaders of those WGs are called 'convenor' in IEC.

We, IEC TC 119, are working under this leadership and structure to develop international standards for Printed Electronics. The member countries of IEC TC 119 are 12 P-member(primary); CH, CN, DE, ES, FI, GB, NL, JP, KR, RU, SE, US, and 8 O-member(observer); BE, BR, CA, CZ, FR, IT, MY, PL.

IEC TC 119 WG3 Equipment

Under leadership of Mr. Taik-Min Lee(KR), WG3 of IEC TC 119 is developing standards for equipment that produces products through printing process. 'Equipment' includes anything, such as inkjet print head, produces printed electronics products. The member countries of WG3 are CN, DE, ES, FI, GB, JP, KR and US.

Table 2: IEC TC 119 working groups

WG	Title	Convenor
	Scope	
1	Terminology	Mr. Alan Hodgson(GB)
	To produce terminology definitions for the field of printed electronics.	
2	Materials	Ms. Chizu Sekine(JP)
	To develop measuring methods and evaluation methods for materials such as substrates, inks and related materials for printed electronics.	
	To analyse the effectiveness of the existing methods specific to the materials of printed electronics.	
	To define specific terms and to determine assessments, requirements, and specifications for materials of printed electronics.	
3	Equipment	Mr. Taik-Min Lee(KR)
	Standardization for printing, coating, other related equipment, tools, sub-units and parts, used for the manufacture and evaluation of printed electronics	
4	Printability	Mr. Chung-Hwan Kim(KR)
	The measurements or requirements of both the qualities of printed patterns and the reproducibility of printing designs as the result of interaction of printing media, inks, substrates, and environmental conditions. Concerning process conditions for some specific products, they would be discussed at sectional specification or blank detail specification. Printing media includes the parts involved in printing process such as plate, cliché, blanket, nozzle, etc, excluding inks and substrate.	
5	Quality assessment	Mr. Christian Punckt(DE)
	The work process in this group will generate test methods and procedures for the measurement of specified product parameters, for lifetime assessment and for reliability testing and stressing of printed and/or flexible electronics components and products.	

International standards for inkjet printing

There are several TCs in IEC and ISO produced international standards related inkjet printing. Table 3 shows some of those.

Table 3: TC/SC related to inkjet printers

TC/SC	Title
ISO TC 130	Graphic Technology
ISO/IEC JTC1/SC28	Office equipment

Within those committees, they are developing several standards related to inkjet printers (see Table 4).

Table 4: examples of published standards for inkjet printers

No.	Title
ISO/IEC 24711	Method for the determination of ink cartridge yield for colour inkjet printers and multi-function devices that contain printer components
ISO/IEC 29102	Information technology - Office equipment - Method for the determination of ink cartridge photo yield for colour printing with inkjet printers and multi-function devices that contain inkjet printer components

However, none of those is directly related to printed electronics technologies. In addition to lack of proper standard for printed electronics, there is no practically useful standard to evaluate quality of printed result by inkjet printing, especially for printed electronics. Unlike conventional printing, that purpose is seen by human being by reflecting light, the important characteristics of printed result of printed electronics is the electrical function that provided by printed trace, such as conductivity. For instance, in order to obtain good electric conductivity, it is important to have good evenness, such as line-width and/or height of printed line, is very important, that is not that important for conventional printing.

Business aspect of inkjet printers

Other non-technical aspect that is different between conventional printing and printing for printed electronics is that business style of inkjet printing. In general cases, an inkjet printer is usually produced by 'A' company. Usually that 'A' company also produces suitable inks and inkjet heads. That means that whole printer including inkjet heads, inks and printer itself is produced by 'A' company. For a printer for printed electronics printing, usually that is not a case. In some cases, a printer by 'D' company has inkjet heads from 'C' company uses inks from 'B' company. This is called difference of business value-chain between conventional printing and printing for printed electronics. Figure 1 shows an example of value chains

Due to this business value chain difference, when inkjet printer vendors develop an inkjet printer for printed electronics, they need to know detail characteristics of those components of inkjet printers.

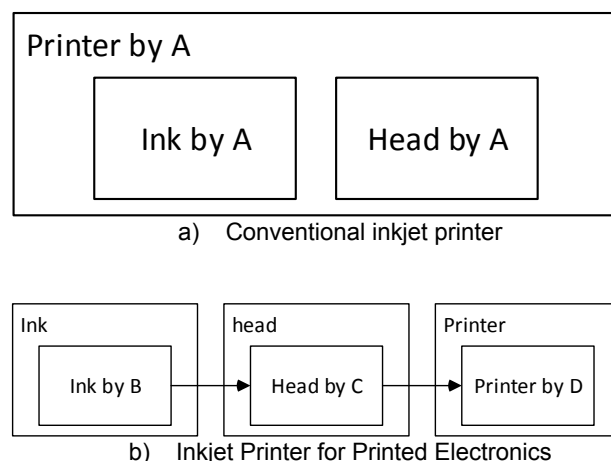


Figure 1: An example of inkjet printer value chain

International standards for inkjet printers by IEC TC 119

In order to answer that needs from printed electronics industry, IEC TC 119 started developing several international standards for inkjet printer. Ink as material is handled within WG2, materials (shown in table 5).

Table 5: Standards for ink from IEC TC 119 WG2, materials

No.	Title
IEC 62899-202:2016	Materials - Conductive ink
IEC 62899-202-3	Materials - Conductive ink - Measurement of sheet resistance of conductive films (contactless method)
IEC 62899-202-4	Materials - Evaluation method of stretchable functional ink (conductive ink and insulator layer)
IEC 62899-202-5	Materials - Conductive ink - Mechanical bending test of a printed conductive layer on a substrate
IEC 62899-202-6	Materials - Conductive film – Environmental test of a printed metal based conductive layer on flexible substrate
IEC 62899-202-7	Materials - Conductive ink – Measurement of peel strength for printed conductive layer on flexible substrate
IEC 62899-203	Materials - Semiconductor ink
IEC 62899-204	Materials - Insulator ink
IEC TR 62899-250:2016	Material technologies required in printed electronics for wearable smart devices

For inkjet equipment, WG3 is working on standards for inkjet printers as shown in table 6.

Table 6: Standards for inkjet printer from IEC TC 119 WG3

No.	Title
IEC 62899-302-1:2017 ED1	Equipment - Inkjet - Imaging based measurement of jetting speed
IEC 62899-302-2:2018 ED1	Equipment - Inkjet - Imaging-based measurement of droplet volume
PNW 119-208	Equipment – Inkjet – Imaging-based measurement of drop direction

(Note: PNW is preliminary new work items)

In addition to those standards, WG3 is considering further items related to ink jet technologies, especially evaluation methods for printed result that is very important for printed electronics products.

Basic idea of inkjet print measurement

The following figures show basic idea of inkjet print measurement method. IEC 62899-302-1:2017 ED1

Equipment - Inkjet - Imaging based measurement of jetting speed defines ‘jetting speed’ measurement like figure 2.

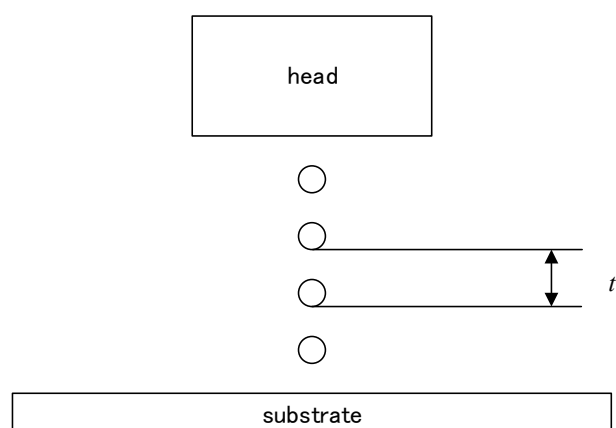


Figure 2 – an example of jetting speed measurement

IEC 62899-302-2:2018 ED1 Equipment - Inkjet - Imaging-based measurement of droplet volume defines ‘droplet volume’ measurement like figure 3.

PNW 119-208 Equipment – Inkjet – Imaging-based measurement of drop direction will define imaging based ‘jetting direction’ measurement, like figure 4.

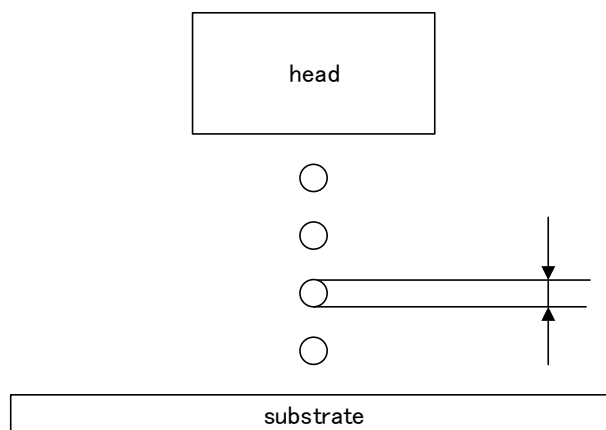


Figure 3 – an example of droplet volume measurement

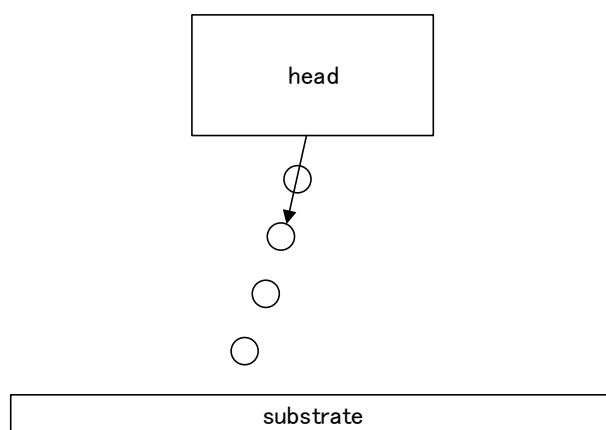


Figure 4 – an example of jetting direction measurement

The next steps

We, IEC TC 119 WG3, plans to have further standards for inkjet technologies, such as ink placement of dropped ink. In order to evaluate inkjet technologies for printed electronics, it is necessary to study what other parameters other than already defined in our IEC TC 119 standard. We, IEC TC 119 WG3, continue discuss that matter. If there is any ideas or request of having new standards for inkjet technologies for printed electronics, please let us know.

Yamagata University

In order to answer that request from IEC TC 119 WG3, Yamagata University established ‘inkjet research center’ in its ‘Organic electronics innovation center’ (Figure 5) led by Dr. Shinri Sakai. Within that inkjet research center, they have consortium that consists of several corporations related to inkjet technologies (see Figure 6).



Figure 5 – Yamagata University Organic electronics innovation center

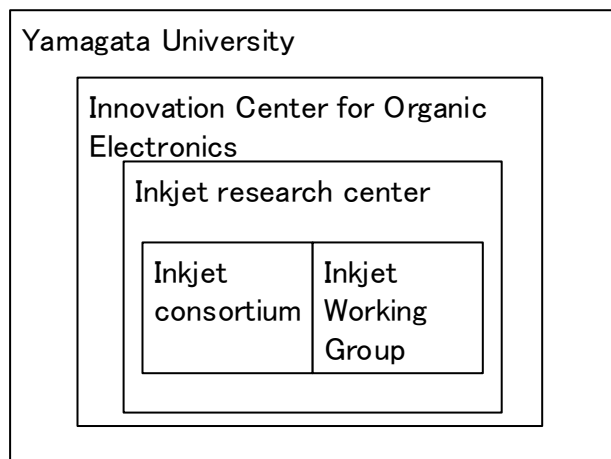


Figure 6 – Yamagata University inkjet research center

Within this research center, they are going to study inkjet technologies and ink rheology. Their aim is going to bring certain result to IEC TC 119 to have proper measuring methods of inkjet technologies.

Within this research center, they are going to study inkjet technologies and ink rheology. Their aim is going to bring certain result to IEC TC 119 to have proper measuring methods of inkjet technologies.

Inkjet research center is located near Yonezawa station in Yamagata prefecture.

Acknowledgement

This paper is not available without having lots of effort and time consuming discussion of our IEC TC 119 experts from World Wide. Special thanks to JEITA, Japan Electronics and Information Technology Industries Association providing huge help for us to work in IEC TC 119. Very special thanks to IEC TC 119 officers and convenors to manage IEC work.

Yamagata University Inkjet research center provides fund for reporting this to IS&T.

References

- [1] Masaaki Oda, et al. "The First International Standards for IEC/TC 119 Printed Electronics Materials Substrate and Conductive Ink", IS&T Printing for Fabrication, pp314-318 (2016)
- [2] Fundamentals of Inkjet Printing: The Science of Inkjet and Droplets, Stephen D. Hoath ISBN: 978-3-527-33785-9
- [3] On International Standards for In-flight Measurements of Inkjet Drops; Stephen D. Hoath: Journal of Imaging Science and Technology, 62(1): 010401-1–010401-8, 2018.

Author Biography

Kei Hyodo received his BS in applied chemistry from the Kohnan University (1982). Since then he has worked in the Research and Development Division in Mita Industry Co. Ltd, Konica Minolta Ltd., and Yuasa System Co. Ltd. in Japan from 2018, and from 2018 work as Professor of Industry Relations at Yamagata University. From 2011, he started working as an assistant secretary of IEC TC 110, Electronic Display Devices, from 2014 working as an expert of IEC TC 119, Printed Electronics