TACTOTEK

IMSE and Standardization

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Abstract

This paper presents standardization activities at TactoTek. IMSE stands for “Injection Molded Structural Electronics” and IMSE technology enables smart molded structures. They are made by integrating and encapsulating printed electronics and standard electronic components within durable, 3D injection-molded plastics. IMSE technology and processing differs significantly from conventional electronics where components are reflow soldered onto printed-circuit-boards. Thus many of the standards developed for conventional electronics are not relevant for IMSE.

Why Standardize?

Traditionally the purpose of standardization has been to consolidate best practices. At first, group of experts have met and shared their views. They have discussed and debated them, maybe done more research. In the end the, experts have come up with a method that all agree with. They document the method and make it available also for others. This way, more companies can implement the best practice.
Standardization work takes place at several industrial consortiums, such as JEDEC that prepares standards for the microelectronics industry or at Automotive Electronics Council (AEC) that sets standards for components. In addition, there are several standardization organizations that cover many areas. An example is International Organization for Standardization (ISO). ISO claims that one of the most popular standards is ISO 9000 Quality standard family [1].
Motivation to standardize is also to speed up industrialization of new technologies. TactoTek has created vast amount of new knowledge while developing IMSE. The company protects its knowledge with IPRs. TactoTek also disseminates knowledge with its Licencing business-model as swell as organizing events such as IMSE Days. In addition, TactoTek can disseminate some knowledge with standards. When TactoTek and its key-partners create standards that benefit the IMSE ecosystem, they are also speeding up the industrialization IMSE technology.

IEC and IPC Create Printed Electronics Standards

Since TactoTek cannot use most standards made for conventional electronics, we have looked to other advanced technology areas such as Printed Electronics. The two global organizations that create standards for Printed Electronics are IEC and IPC.

IEC stands for International Electrotechnical Commission. This is a global organization that has the central office in Switzerland. IEC launched the Technical Committee for Printed Electronics in 2012. Figure 1 shows the working groups that are responsible for the standard creation. Sofar, IEC has

published around 20 standards for printed Electronics [2]. Participation to IEC work is via its National Committees and Table 1 lists national committees in selected countries.

IPC stands for Association Connecting Electronics Industries. It is founded in USA but acts globally. IPC launched it's committee for printed electronics in 2011. The committee is called D-60 and has also several sub-committees, Figure 2. The standardization scope in printed electronics Sub-groups is similar to IEC, even if naming differs. IPC has published about 10 standards [3]. Participation to IPC is via sub-committees.

TactoTek has followed Printed Electronics standardization development in IEC and in IPC for the past 1.5 years. None of the standards, sofar are in IMSE core.

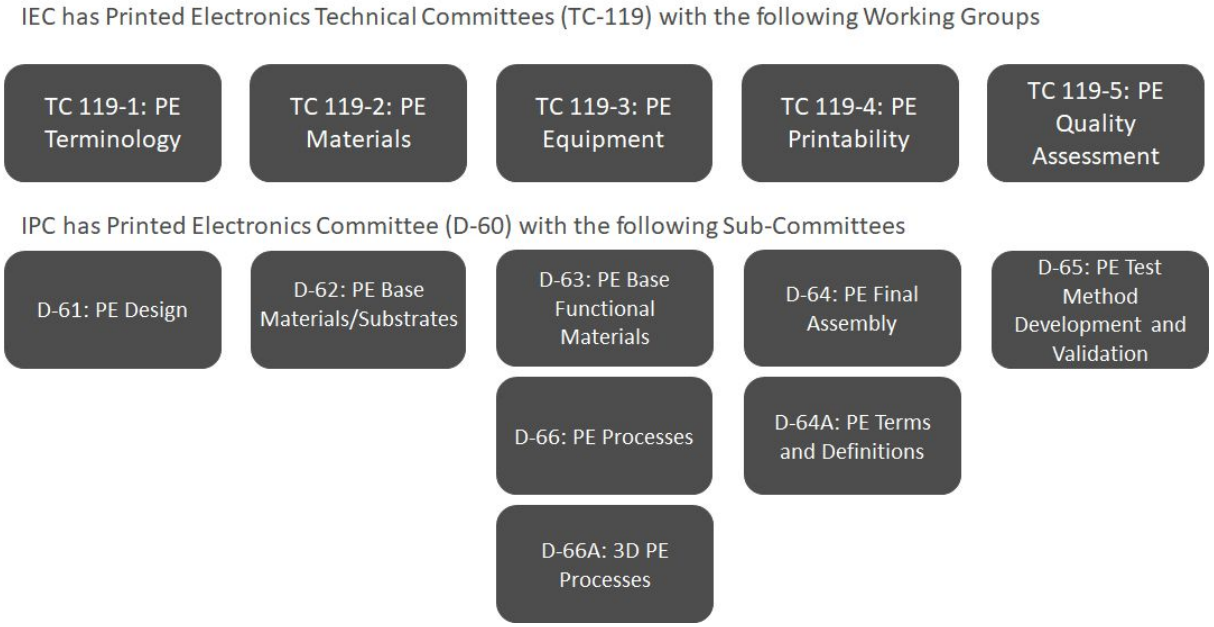

Figure 1 - IEC TC-119 and IPC D-60 create standards for Printed Electronics.

Table 1 - IEC national committees in selected countries [4]

Country	National committee	Website
Finland	SESKO	sesko.fi
France	Afnor Group	afnor.org
Germany	DKE	dke.de
Italy	CEI	ceinorme.it
United Kingdom	BSI	bsigroup.com
United States of America	ANSI	ansi.org

What to Standardize?

TactoTek naturally promotes IMSE industrialization and thus is active also with standardization. Figure 2 shows the current focus areas.

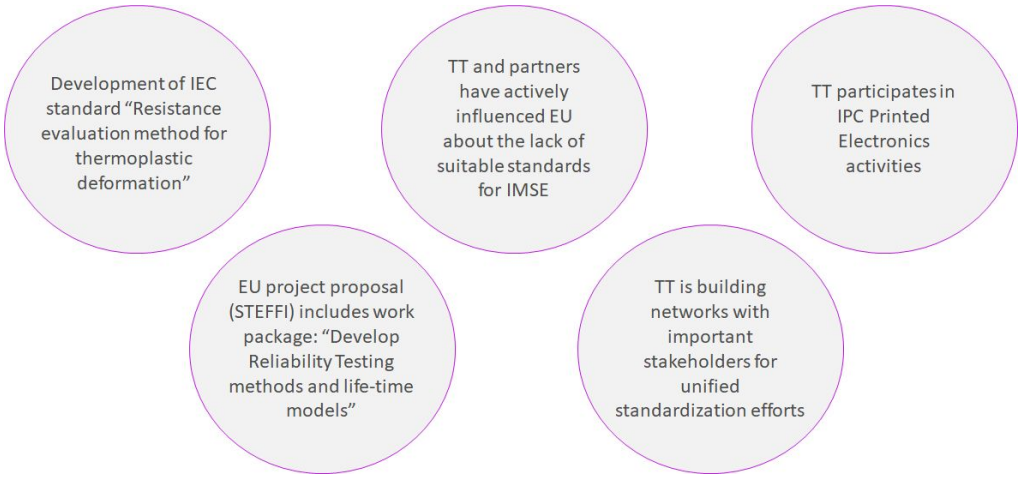

Figure 2 - Current focus areas in standardization

Trace Resistance Change During Thermoforming

TactoTek has started to develop IEC standard for measuring the resistance change in conductive layers during thermoforming that is one of IMSE manufacturing processes. During thermoforming, two-dimensional film substrates form into three-dimensional shapes, Figure 3. When this happens, the films and conducting layers deform plastically. In other words, they stretch. We need to know how conductive layer resistance changes as a function of plastic strain. This information is seldomly available from ink suppliers. Moreover, there is no shared measurement or analysis methodology. Thus, results cannot be compared between ink suppliers.

Figure 3 - Illustration on left shows two-dimensional IMSE film after printing. Illustration on right shows three-dimensional film after thermoforming (and cutting).

TactoTek has made resistance-strain measurements for conductive inks already in 2015. At the moment the company is developing the method so that it is better suited for thermoforming process. We have proposed to IEC Printed Electronics Technical Committee that it becomes a standard "Resistance evaluation method for thermoplastic deformation". IEC Printed Electronics

Working Group 119-2 has accepted it as preliminary work item (PWI) . An average development time for an IEC standard is 3 years [5]. We expect to have the standard out in 2021.

Reliability testing and Life-Time Models

Printed circuit board materials, such as FR-4, tolerate higher temperature than most plastic films used in IMSE. Typical maximum operating temperature for FR-4 is around 130 ◦C. Many elevated temperature and thermal cycling tests assume that the substrate material is FR-4. Thus, they have maximum temperature of 125 ◦C or even 155 ◦C. Typically, IMSE substrate materials cannot tolerate those temperatures. Furthermore, those temperatures are not relevant for most application environments. The reliability tests include high temperatures to increase their acceleration factors and to reduce test times. Many OEMs hesitate to test at the lower temperatures, such as 85 °C, because they do not know how compare the test results with testing at higher temperatures. Thus, we want to develop reliability and life-time models for IMSE that take into account the thermal limitations of polymer materials.

This kind of work takes a lot of resources and thus TactoTek is part of consortium that has applied for EU funding for a project called STEFFI. The abbreviation STEFFI comes from words “Structural Electronics for Functional Integrated Systems”. The mission of the project is to accelerate the industrial exploitation and technology competitiveness of structural electronics. The project includes also other structural electronics technologies, for example, embedding components inside glass. STEFFI is a large project and covers many aspects such as materials, design, manufacturing and testing. TactoTek has proposed that this project includes work for developing reliability testing for injection molded electronics as well as developing life-time models for them. This is still in proposal phase and EU will make the funding decision in November 2019.

Summary

IMSE technology and processing differs significantly from conventional electronics where components are reflow soldered onto printed-circuit-boards. This means that most of the standards developed for conventional electronics are not relevant for IMSE. When TactoTek and its key-partners create standards that benefit the IMSE ecosystem, they are also speeding up the industrialization IMSE technology.

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