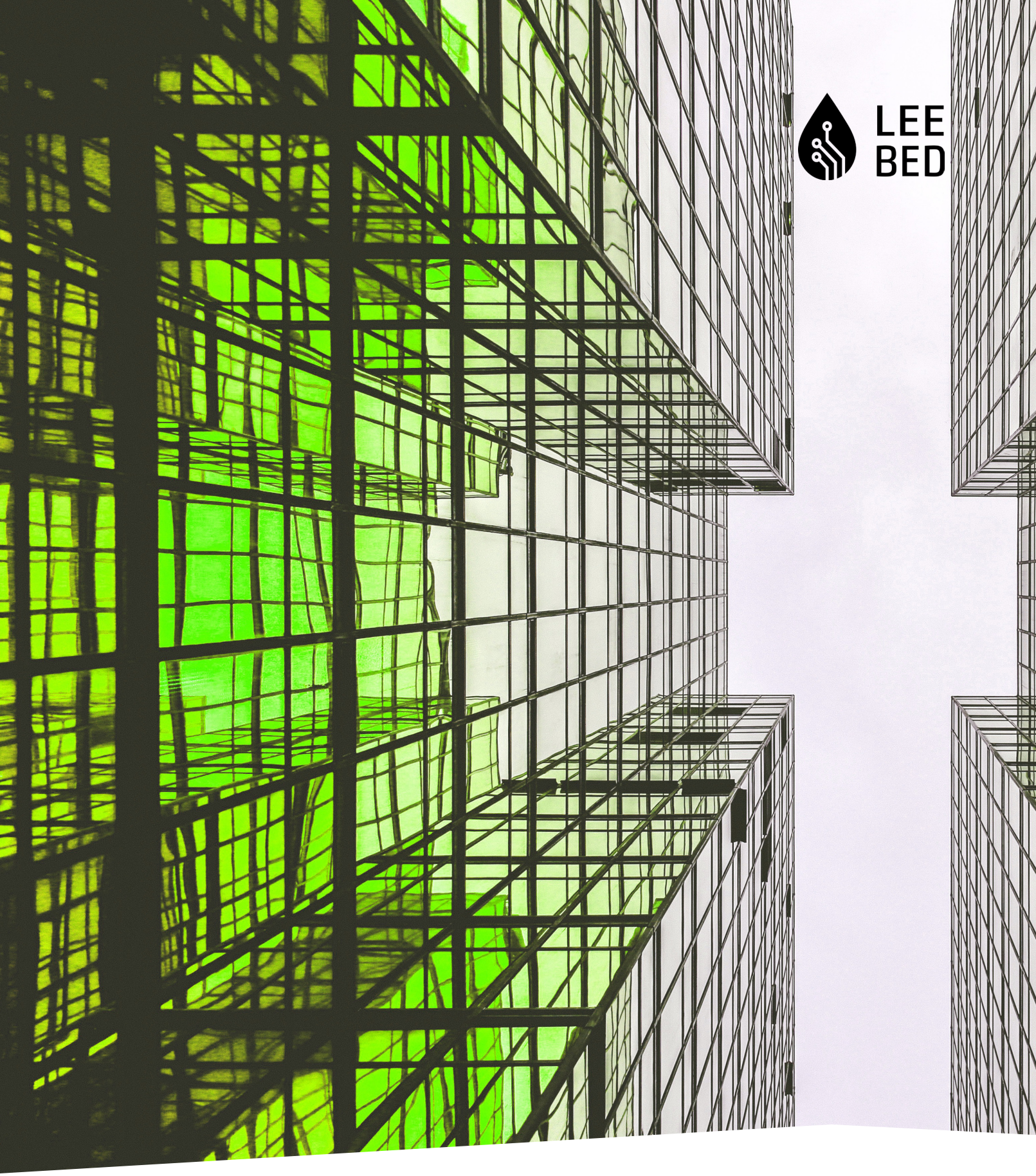

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GLOBAL TRENDS IN PRINTED ELECTRONICS – PATENT MAPPING

REPORT JANUARY 2020

DANISH TECHNOLOGICAL INSTITUTE

Titel:
Global Trends in Printed Electronic - Patent Mapping
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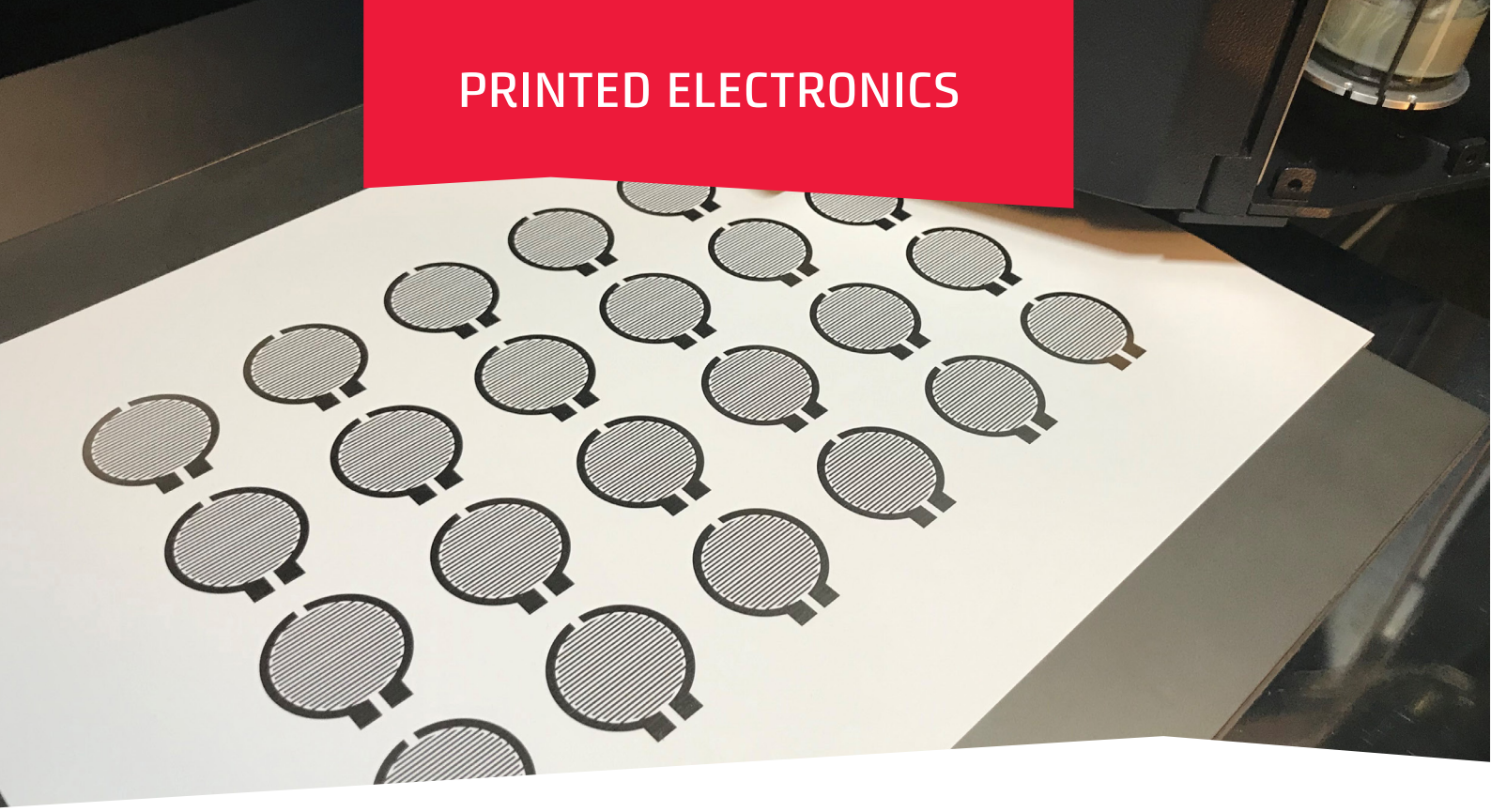
Content



Into the future with printed electronics technologies

Printed electronics is an emerging technology offering technological opportunities to produce embedded electronics that are typically integrated in flexible materials, see Textbox 1.

This report presents an overall review of technology developments within printed electronics described by patent data. Our strategy in the search for re-

TEXTBOX 1: WHAT IS PRINTED ELECTRONICS?

'Printed electronics' is an all-encompassing term for the printing method used to create electronic devices by printing on a variety of substrates. Originally, printed electronics related to organic or plastic electronics that use one or more inks made of carbon-based compounds. As demand for wearable devices and thinner electronics expands, printed electronics is used to form flexible keyboards, antennas, electronic skin patches and more.

Printed electronics has become secure, flexible, and cost-effective, all of which make the technology appealing to a broad range of industries. Printed electronics has the potential to reduce costs and technical constraints typically associated with mass producing electronics.

Source: https://www.pannam.com/blog/what-is-printed-electronics/

PRINTED ELECTRONICS

levant patents is to identify a core set of patents that are highly relevant to printed electronics. Such a broad scan of patents indicates to which extent the industry should pay attention to printed electronics. Thus, we have identified 16,537 patent families related to printed electronics which can be used as a point of departure for more detailed searches such as searches for specific technological solutions or applications. If your company wants to develop new products incorporating printed electronics, we recommend a detailed search that provides you with strategic business intelligence about current technological solutions and potential competitors/partners[1].

In the last decades, printed electronics has undergone significant technological developments, and especially in the last few years the numbers of patents mentioning printed electronics has increased significantly. In the period 2015-2018, 32% of all patents from 2000-2018 have been published. Currently, significant technological developments are taking place within printed electronics, and market forecasts expect a marked increase in turnover in the printed electronics market in the future. The industry has increasingly focused on the many new possible printed electronics applications and companies, and research organisations have developed an increasing number of unique printed electronics solutions.

Even though printed electronics represents many different groups of technologies, about one in four patents is classified as printed circuits on flexible materials and a little under a fourth of the patents is characterised by the use of flexible or folded printed circuits.

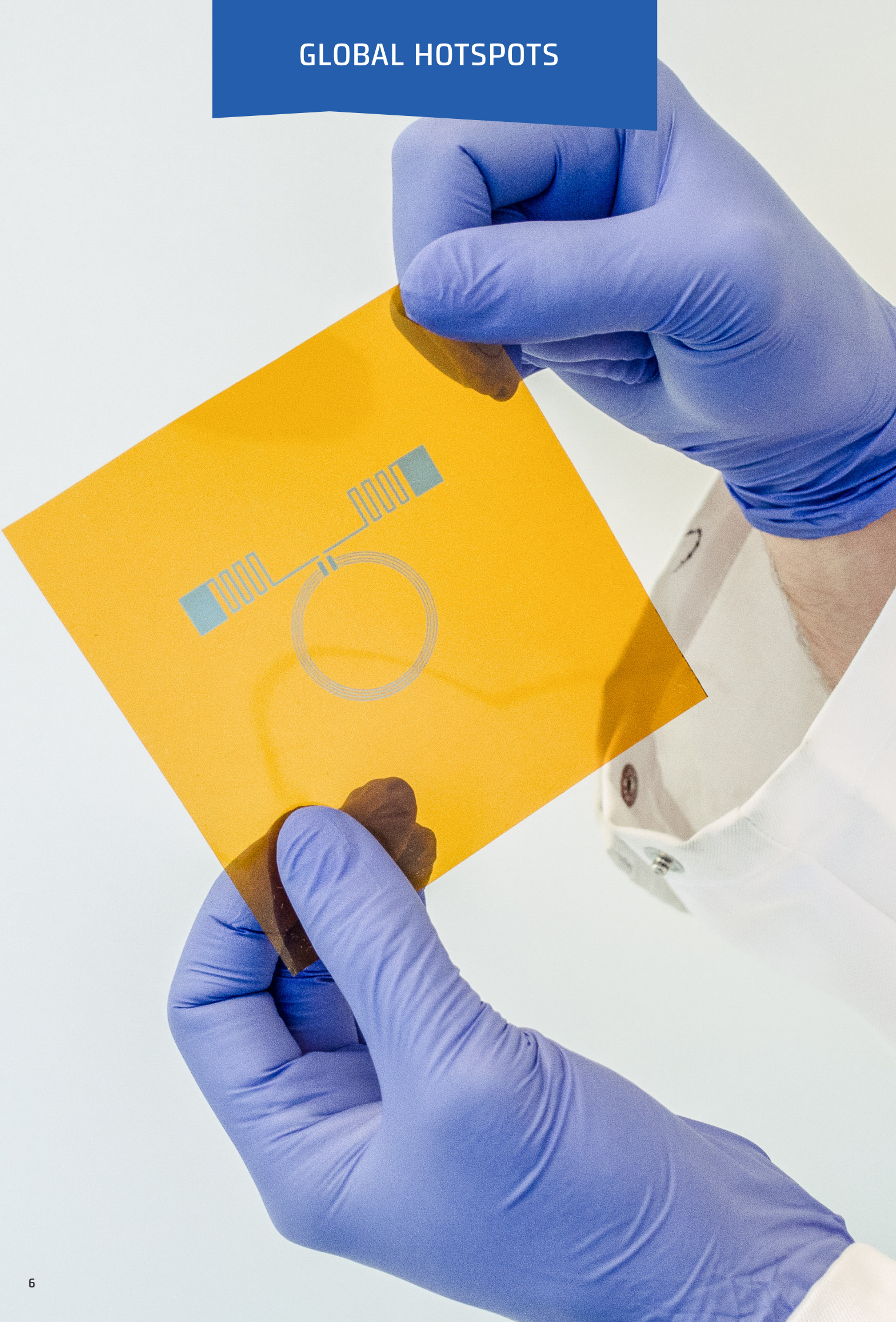
In 2015, approx. 80% of all assignees, e.g., patenting companies, were based in three countries with Japan topping the list followed by the US and South Korea meaning that Japanese, US, and South Korean companies are the main technological developers of printed electronics. However, in 2015, China entered the printed electronics stage and the numbers of patents granted to assignees in China rose dramatically. In 2018, Chinese assignees stood for most printed electronics patents. Europe is lacking behind with Germany as the exception.

Since 2000, most of the patents within printed electronics have been granted in the US. Thus, the US dominated the field in 2018 by number of published patents and will presumably continue to do so in the future.

This report is divided into two sections, i.e., a global and a European perspective. The first section of the report presents global hotspots with the most frequent keywords in the identified patents and it presents a landscape for printed electronics-related technologies. Furthermore, the global hotspots present the intensity of patent publications across time, by countries and across patenting companies. The second section focuses on patents granted to European companies as we want to examine the global position of European companies as well as geographical differences within Europe.

[1] For a detailed presented of our applied method, see Danish Technological Institute (2019): Patent mapping your idea (www.teknologisk.dk/40890)

GLOBAL HOTSPOTS



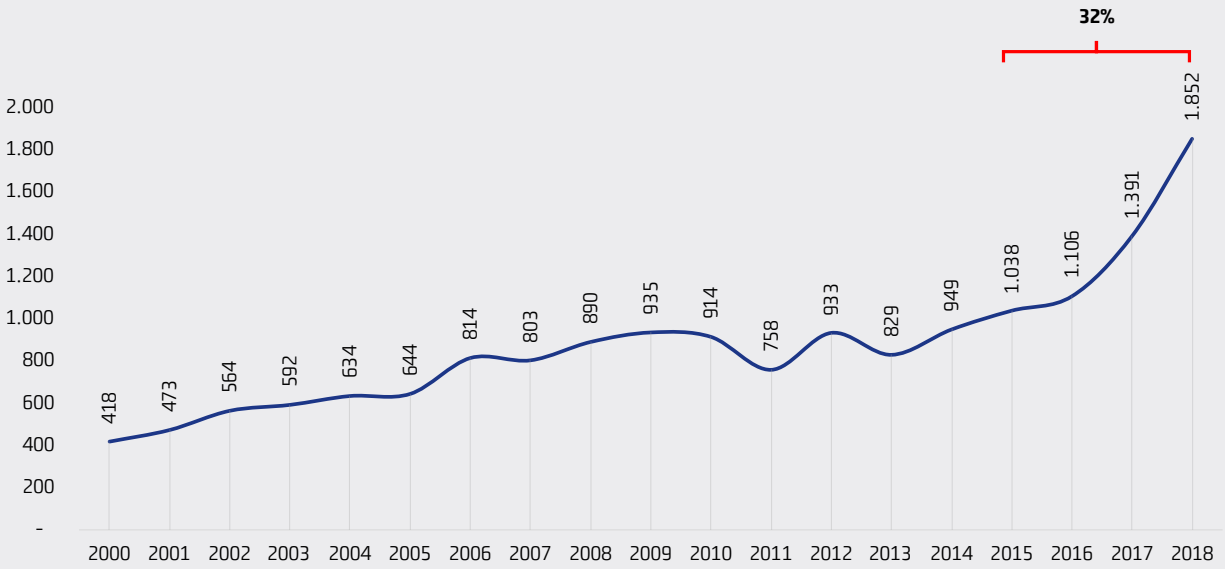
Global hotspots within printed electronics

For the period 2000 to 2018, we have identified 16,537 patent families related to printed electronics. Over this period, the number of printed electronics patent publications developed incrementally until 2015 when the number of patents took off with 32% of printed electronics patents being published in the period 2015-2018, see Figure 1. Since the processing time for patents to be published can last a few years the number of printed electronics patents from 2017 and 2018 is expected to rise even more.

Market studies estimate that the market for printed electronics will grow significantly in the future as the total market is expected to grow from USD 41.2 billion in 2020 to USD 74 billion in 2030[2]. Thus, the number of patents will presumably continue to grow in the future.

[2] IDTechEx: Flexible, Printed and Organic Electronics 2020-2030: Forecasts, Players and Opportunities (https://www.idtechex.com/en/research-report/printed-organic-and-flexible-electronics-2020-2030-forecasts-technologies-markets/687).

FIGURE 1: PUBLISHED PATENTS WITHIN PRINTED ELECTRONICS, 2000-2018



Note: Extract 10. oct. 2019. N: 16,537 patent families.
Source: PatSnap, processed by Danish Technological Institute

Global technological hotspots

We have identified a group of approx. 16,000 printed electronic-related patents using the technological classification system Cooperative Patent Classification (CPC), see Textbox 2[3].

Patents usually feature more than one CPC-code. Hence the total numbers of patents distributed by CPC-codes will exceed 16,537 in Figure 2. In the group of printed electronics related patents, the

[3] See page 19 for an introduction to the applied method

TEXTBOX 2: SHORT INTRODUCTION TO THE SYSTEM USED TO CLASSIFY TECHNOLOGY

The Cooperative Patent Classification (CPC-codes) is an internationally compatible classification system for technical documents, especially patent publications. The CPC-classification system is an extension of the IPC (International Patent Classification), which is administrated by the World Intellectual Property Organization (WIPO). The CPC-classification system is more detailed than the IPC-system. CPC is managed by the European Patent Office (EPO) and the US Patent and Trademark Office (USPTO). The two patent offices have agreed to harmonise their existing classification systems and migrate towards a common classification scheme.

The CPC-codes are divided into nine sections, i.e., A-H and Y, which in turn are subdivided into classes, sub-classes, groups, and subgroups. There are approx. 250,000 classification entries.

Source: Website of Cooperative Patent Classification: www.cooperativepatentclassification.org

GLOBAL HOTSPOTS

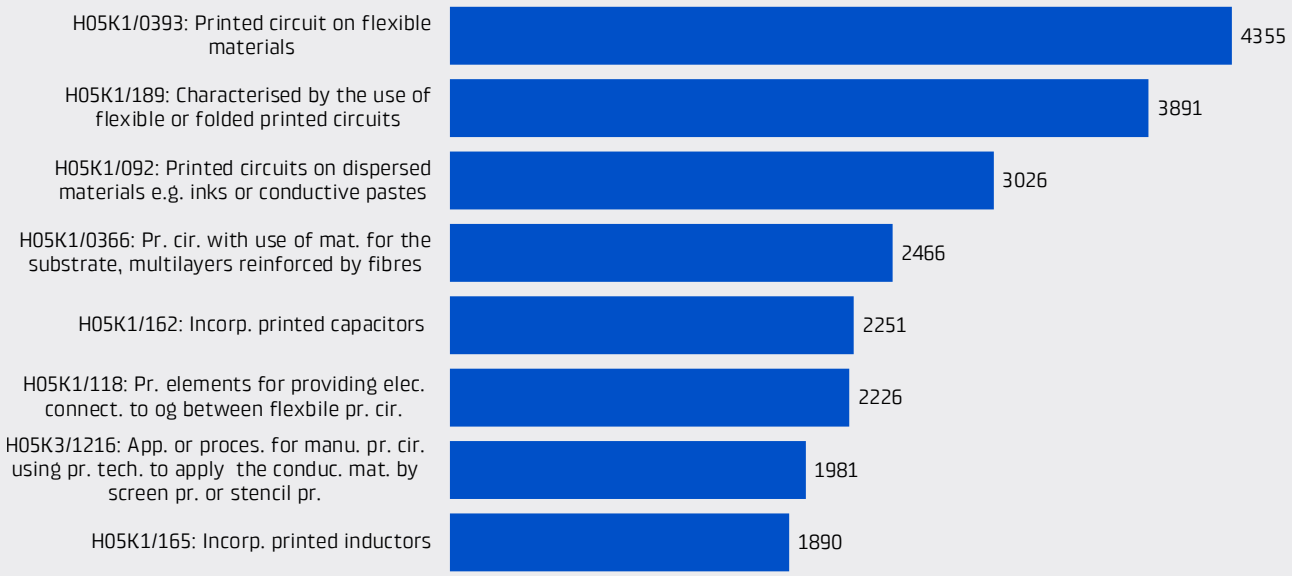
two most applied codes may be of particularly interest. About one in four patents is classified as printed circuits on flexible materials and a little under a fourth of the patents is characterised by the use of flexible or folded printed circuits. The two CPC-codes about flexibility and printed circuits will therefore most likely capture some of the same patents and this is one of the reasons why the sum is above 16,537 in the bar chart.

Flexibility is a main characteristic of printed electronics, but it is not a necessary condition for being classified as printed electronics. Therefore, other codes are necessary for capturing printed electronics related patents. The third most frequently used CPC-code is printed circuits on dispersed materials such as inks and conductive pastes and the fourth most frequently used code is printed circuits with use of materials for the substrate, multilayers reinforced by fibres.

Apart from the CPC-codes, patents are also described by key words. By clustering keywords, we can create a 'landscape'. A high density of patents is illustrated as a peak or a plateau in Figure 3. The peaks are marked with related keywords behind the patents.

Among all printed electronics related patents, we can identify 12 subgroups, i.e., groups that have

FIGURE 2: NUMBER OF PATENTS BY THE OFTEN-USED CPC-CODES (TOP 8 CPC-CODES)

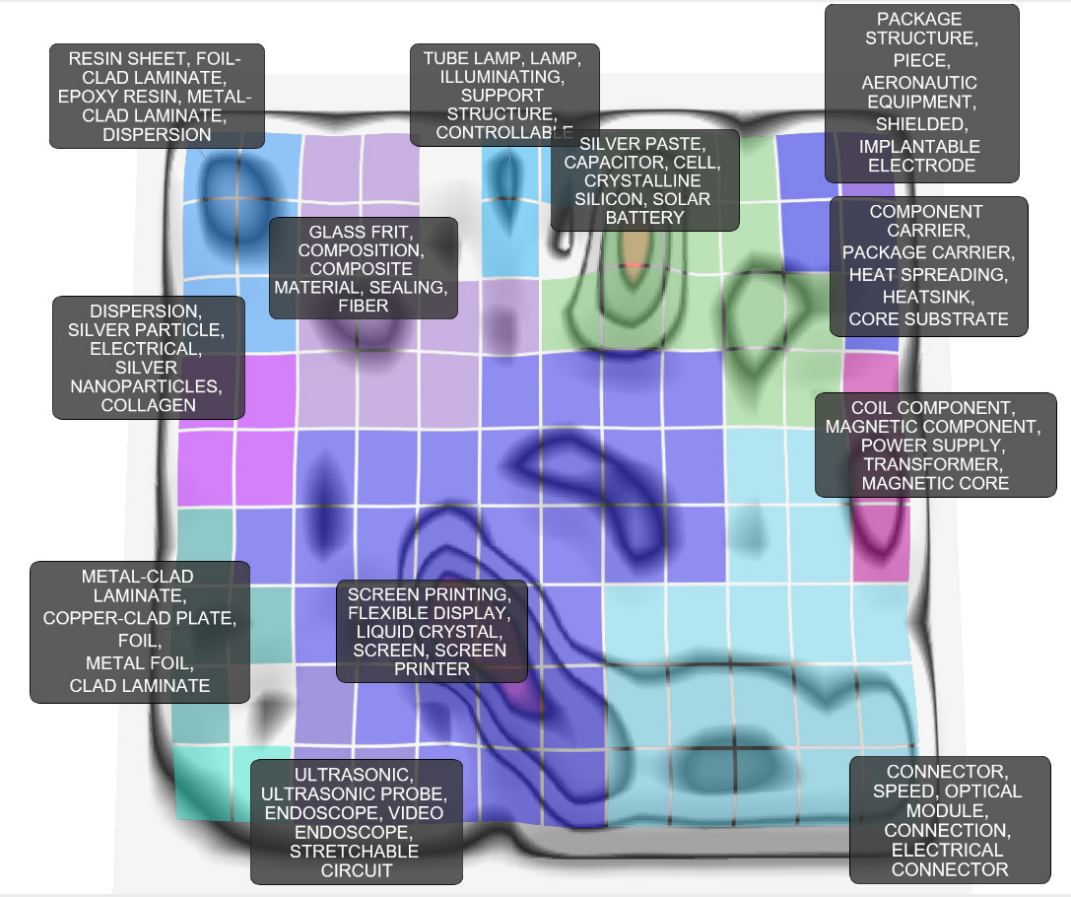


Note: Extract 10. oct. 2019. N: 16,537 patent families.
Source: PatSnap, processed by Danish Technological Institute

verbal similarity and IPC commonality. The peaks are of most interest as they indicate technological density or patent development, while lowlying areas represent untapped areas for potential growth and expansion into new territories - or areas of no interest.

The interpretation of the map can only be made in broad terms, but it does indicate an interrelationship of keywords. The blue area of the map (in the middle) has a peak in the middle. In this area a group of patents is accumulated and has the following common characteristics: screen printing, flexible display, liquid crystal, and screen printer. The second peak is placed in the upper right area of the figure (green area) and is characterised by the keywords silver paste, capacitor, crystalline silicon, and solar battery.

FIGURE 3: INNOVATION LANDSCAPE FOR PRINTED ELECTRONIC-RELATED TECHNOLOGIES



Note: Extract 10. oct. 2019. N: 16,537 patent families.
Source: PatSnap, processed by Danish Technological Institute

Geographically hotspots

Geographical hotspot can be identified by studying the number of patents either by the locational pattern of the assignees[4] or where the assignees have been granted the patent.

First, we study the number of patents by the locational pattern of the assignees. The heat map illustrates that assignees are in a relatively few countries, see Figure 4. From 2000 to 2018 the assignees were mainly located in Asian countries such as Japan and South Korea, at the East and West Coast of the US, in Central Europe and in China. There is a particularly high concentration of patenting companies in Japan and South Korea. However, the present locational pattern for printed electronics seems to represent the same geographical areas where the global high-tech industries and research centres are located.

[4] Current assignee is the person or entity to which this patent is currently assigned which includes private companies, universities, research and technology organisations, etc.

FIGURE 4: NUMBER OF PATENTS BY THE LOCATION OF THE ASSIGNEES, NUMBER OF PATENTS FROM 2000 TO 2018

Note: Extract 10. oct. 2019. N: 16,537 patent families.
Source: PatSnap, processed by Danish Technological Institute

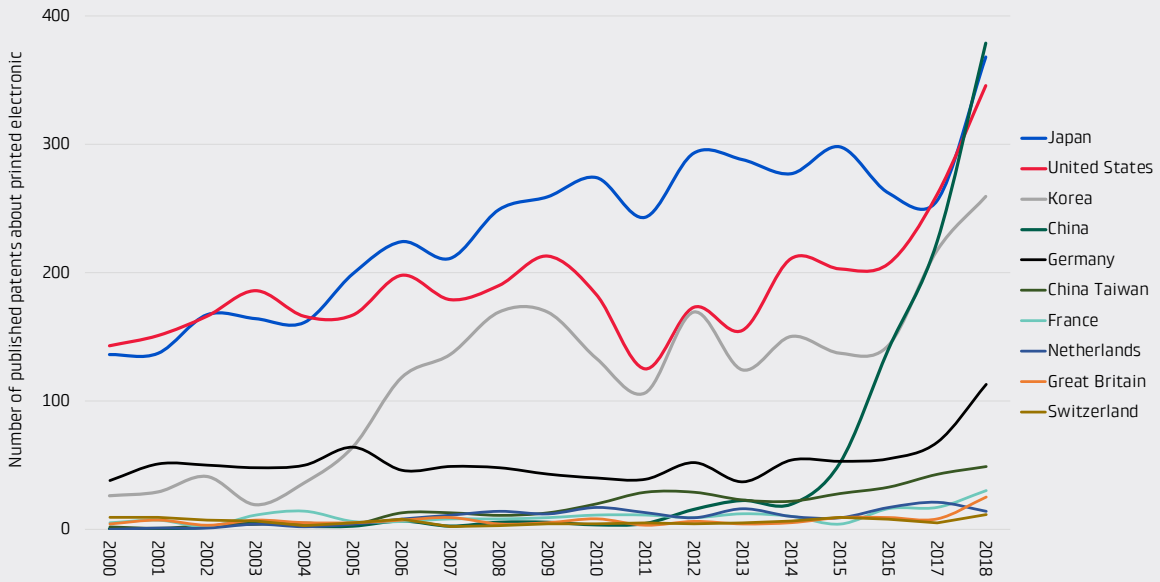
GLOBAL HOTSPOTS

Since 2000, assignees in the US and Japan have been granted the highest number of patents within printed electronics, but in mid-00's Japan became the country in which assignees took out the most patents for printed electronics, see Figure 5. Along with Japan having a dominating position in issuing the most patents the development of the technology increased in South Korea. From the mid-00's to mid-10's South Korea ranged third and the US the second. In 2015, approx. 80% of all patents were granted in these three countries. This implies that the Japanese, US and South Korean assignees represented the main geographical hotspots for technological developments within printed electronics at the time.

In 2015, China entered the stage of printed electronics. The numbers of patents granted to assignees in China are soaring. From 2014 to 2016 the numbers of patents rose 168% each year and from 2016 to 2018 China experienced an increase in the number of patenting assignees between 60-70% each year. This steep increase in Chinese patenting assignees made China the world's most patenting country in 2018.

In Europe, the number of patents granted to European assignees within printed electronics is relatively low. Nevertheless, Germany could be seen in the market taking out patents related to printed electronics during the same period, and there was an increase in the number of patents taken out by German companies which reached a preliminary peak in 2018 with 113 patents.

FIGURE 5: NUMBER OF PATENTS, THE LOCATION OF THE ASSIGNEES WITHIN PRINTED ELECTRONICS, TOP 10 COUNTRIES



Note: Extract 10. oct. 2019. N: 16,537 patent families.
Source: PatSnap, processed by Danish Technological Institute

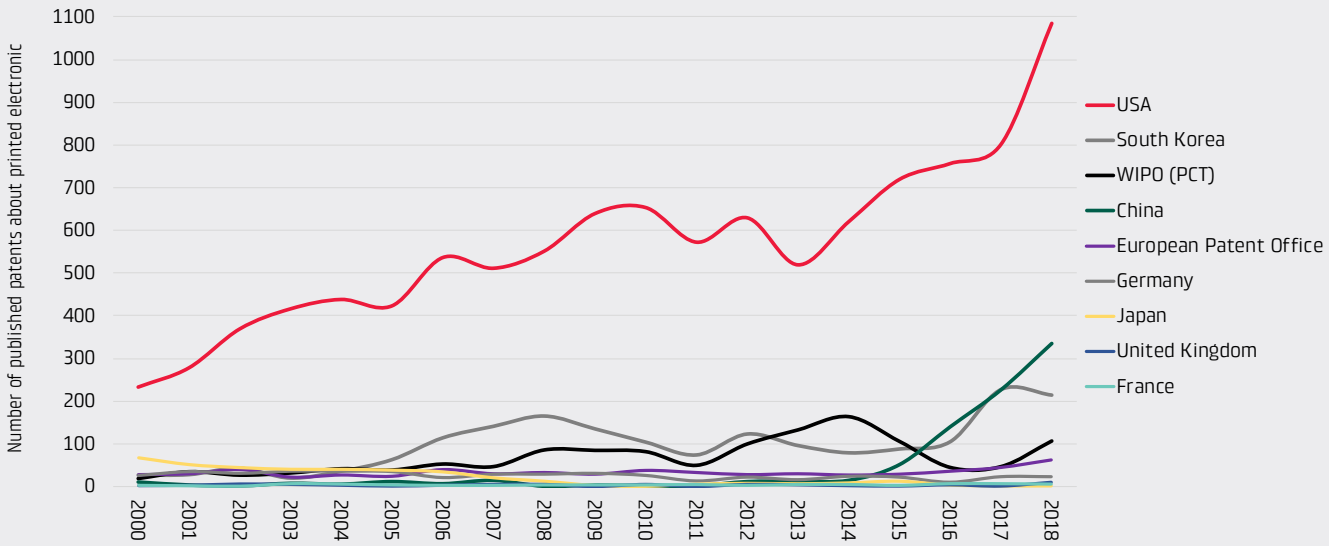
GLOBAL HOTSPOTS

Reviewing the number of published patents by the region or country where the patents have been granted uncover a radically different locational pattern, see Figure 6. By number of published patents, the US has been granting most patents within printed electronics since 2000 and will presumably continue to do so in the years to come. It means that most printed electronics related patents were aimed at the US market, which indicates that the US is the main and most competitive market for using printed electronics.

The second ranging country in 2018 was China with 320 published patents compared to the US with 1075 published patents in 2018. Regardless of the present differences between the US and China, China has experienced an upward curve since 2016 and the trend appears to continue. The third ranking county was South Korea where the number of patents fluctuated during the period and peaked at 226 patents in 2017.

World Intellectual Property Organization (WIPO), European Patent Office (EPO), and patent offices in Germany, Japan, the UK and France are the least patented organisations on the top 9 list. Since 2000 these four counties and two organisations have not experienced a significant increase in the number of patents, and it does not look like they will do so in the years to come.

FIGURE 6: GRANTED PATENTS BY THE LOCATION (COUNTRY) OF THE PATENT OFFICE, 2000-2018



Note: Extract 10. oct. 2019. N: 16,537 patent families.
Source: PatSnap, processed by Danish Technological Institute

The global company hotspots

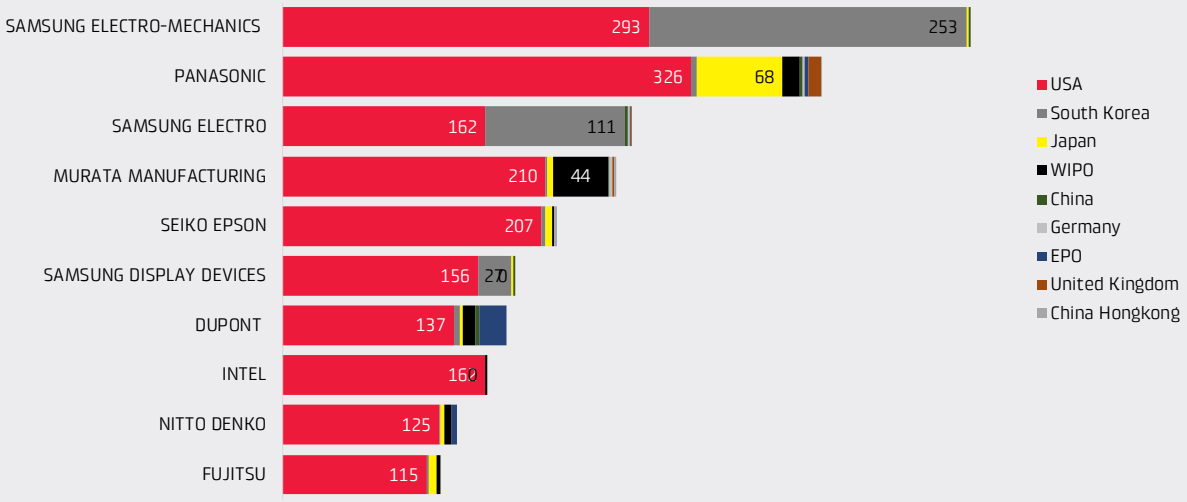
The top global companies[5] are the companies with the most printed electronics related patents. Samsung Group stands out as three of the company's subsidiary companies are represented in the top ten, see Figure 7. Samsung Group has focused on printed electronics for a long time and it has even developed their own copper ink by 2011[6]. The company released the Samsung Galaxy Fold Phone in the spring of 2019, which is an example of one of their products using printed electronics[7].

Panasonic follows Samsung Electro-Mechanics as the company with the second most printed electronics related patents followed by the Japan-based companies Murata Manufacturing and Seiko Epson.

DuPont is the first non-Asia-based and first non-electronics company on the list. DuPont is an US company that produces conductive inks for printed electronics applications. Intel is the only other US company on the top ten list, where no European companies are represented. Most of the top ten companies are based in Japan. However, it is interesting that most of the patents are granted by US patent authorities and are applicable for the US market.

[4] Standardisied current assignee (Current assignee name has been standardised by PatSnap. Current assignee is the person or entity to which this patent is currently assigned).
[6] Raghu Das (2011) Printed electronics progress at Samsung. Printed Electronics World. www.printedelectronicsworld.com/articles/3103/printed-electronics-progress-at-samsung
[7] www.inverse.com/article/56034-samsung-galaxy-fold-flexible-tech-why-it-didn-t-work-but-how-it-could

FIGURE 7: TOTAL NUMBER OF PATENTS BY TOP 10 GLOBAL COMPANIES WITH PRINTED ELECTRONIC-RELATED PATENTS



Note: Extract 10. oct. 2019. N: 16,537 patent families across all companies.
Source: PatSnap, processed by Danish Technological Institute

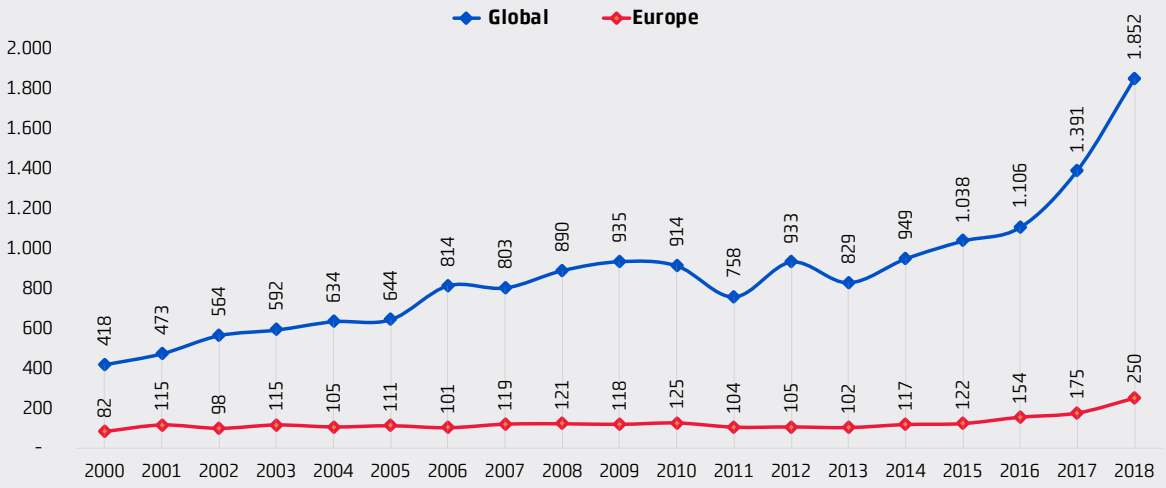
European hotspots

From a European perspective, Europe is among the world regions within printed electronics, but obviously without holding a dominating position regarding publishing patents. In this section, we examine how Europe including Norway, Switzerland, and Iceland are positioned in a global context. We also focus on internal differences.

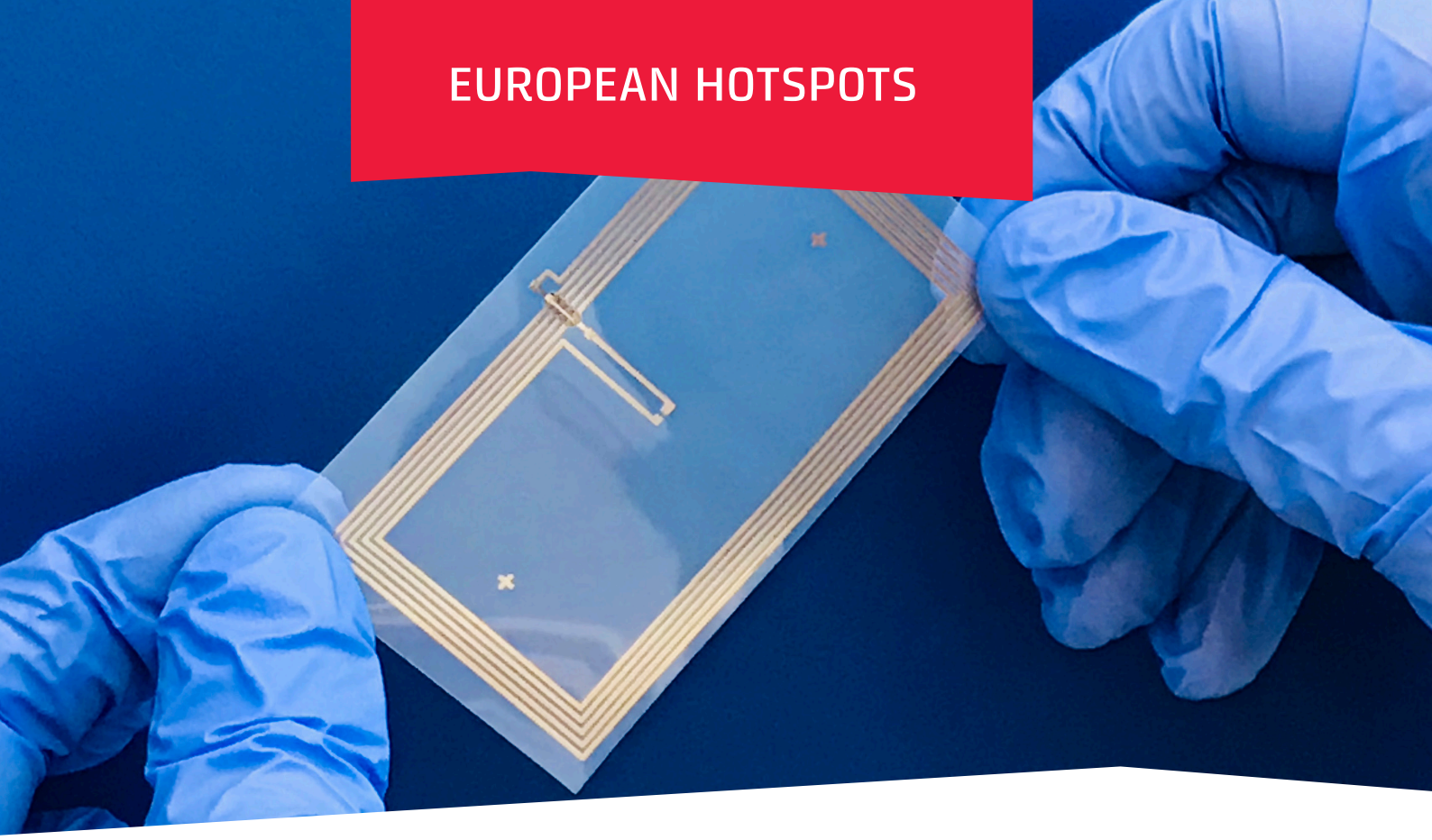
The European share of the patents related to printed electronics

From 2000 and onwards, we observe a slightly increase in the number of patents granted in Europe to assignees. However, in the same period, Europe experienced a declining share of all global patents going from 20% in 2000 to 13% in 2018, see Figure 8.

FIGURE 8: PATENTS IN EUROPE GRANTED TO EUROPEAN ASSIGNEES COMPARED TO THE TOTAL NUMBER OF PATENTS WORLDWIDE



Note: Extract 10. oct. 2019. N: 16,537 patent families.
Source: PatSnap, processed by Danish Technological Institute



Highly industrialised countries more active within printed electronics

Within printed electronics the technological developments expressed by the number of patents granted to European assignees are concentrated in a broad area from Southern Germany/Switzerland over France and Benelux to the UK, see Figure 9. Some minor hotspots can also be found in the Nordic countries.

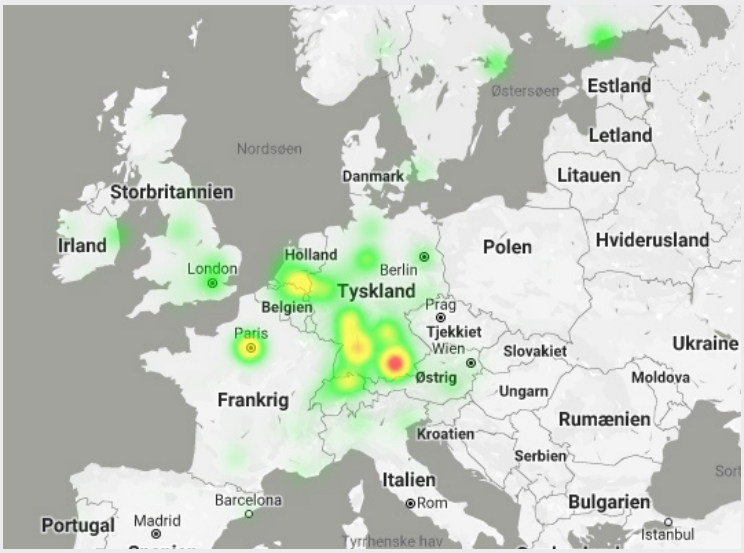
In a regional perspective, the technological developments have mainly taken place in the European urban corridor for decades. This region is characterised by an agglomeration of the main European industries and research organisations investing heavily in technical R&D and hereby they dominate the general technological and economic development in Europe. Technological developments within printed electronics also seem to occur in this region.

In Europe, patenting within printed electronics has mainly taken place in Germany since 2000. Each year, German assignees have been granted more patents than any other European countries, see Figure 10. Globally, the total number of patents have increased significantly since 2015 (cf. Figure 8).

However, in Europe the rapid technological developments since 2015 can only be observed in Germany. In other European countries, such as the UK, France, the Netherlands, and Switzerland, a rather low number of patents has been granted per year since 2000 and only a marginal increase has been seen since 2015.

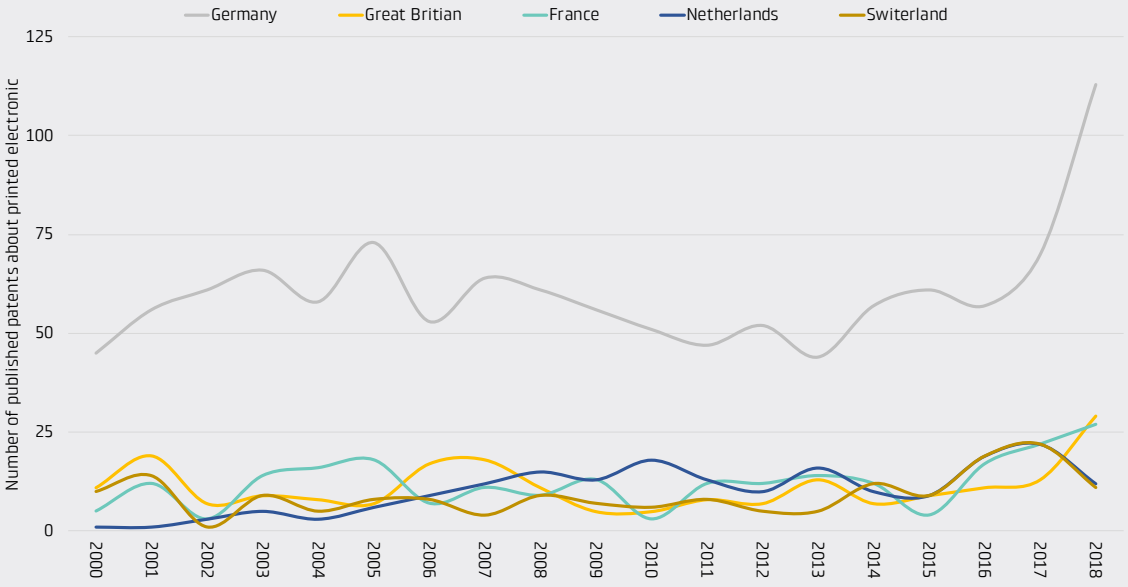
EUROPEAN HOTSPOTS

FIGURE 9: GEOGRAPHICAL DISTRIBUTION OF PATENTS GRANTED TO EUROPEAN ASSIGNEES WHERE THE PATENTS ARE REFERRED TO THE LOCATION OF THE ASSIGNEES.



Note. The figure does indicate in which regions the patent is valid
Source: PatSnap, processed by Danish Technological Institute

FIGURE 10. PATENTS PER YEAR GRANTED TO EUROPEAN COMPANIES BY LOCATION OF THE COMPANIES



Note. The figure does indicate in which regions the patent is valid.
Source: PatSnap, processed by Danish Technological Institute

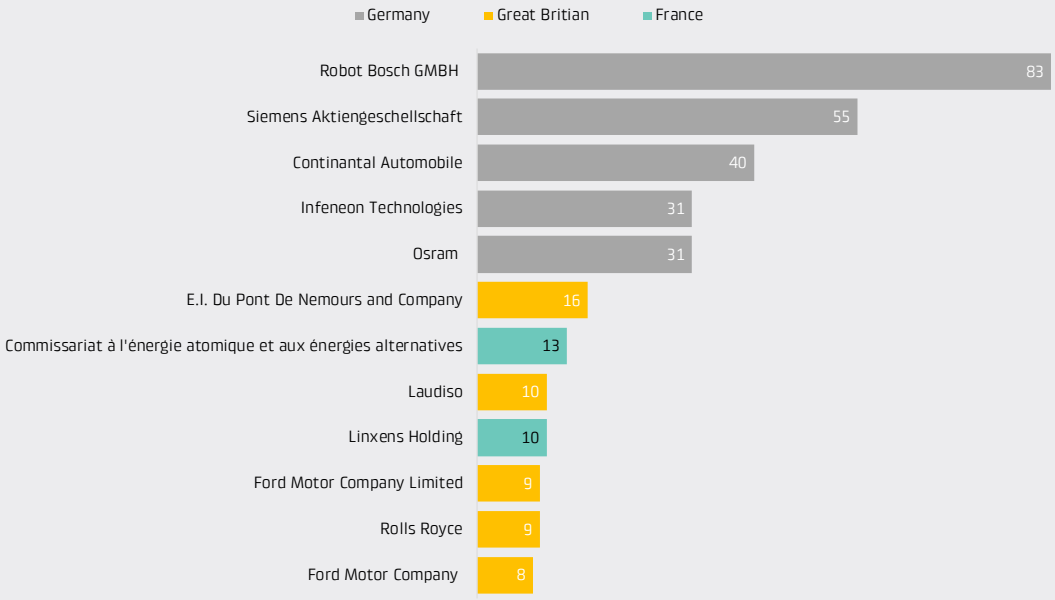
Top European patenting companies within printed electronics

In Europe, we have identified the top 12 companies that hold published patents, see Figure 11. Compared to the number of patents held by the dominating global companies, the European companies hold relative few patents, and even Bosch with the highest number of patents in Europe holds fewer patents than the company that is number 10 on the global top 10 list (cf. Figure 7).

In Europe, five of the top 12 companies are from Germany, holding approx. three out of four patents granted to European companies. The remaining companies are from the UK and France.

According to the industrial sectors that the companies represent, printed electronics mainly appears to be of relevance to the electronics and automotive industries.

FIGURE 11: THE MOST PATENTING EUROPEAN COMPANIES BY NUMBER OF PATENTS, 2000-2018



Note. The figure indicates in which regions the patents are valid
Source: PatSnap, processed by Danish Technological Institute

Method

The patent authorities attach technology codes to the patents. The technical classifications system CPC (Cooperative Patent Classification) applies more than 250,000 unique codes. When doing patent mapping targeting printed electronics, a key task is to identify the most relevant CPC-codes regarding printed electronics and to limit the number of irrelevant patents.

The search strategy has been to identify a core set of patents with high relevance to the technology 'printed electronics' through CPC-codes. The codes identified and included in this study are presented in Table 1.

TABLE 1: CPC-CODES IN THE PATENT SEARCH

Number	Description
H05K1/189	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components. Printed circuits: Printed circuits structurally associated with non-printed electric components. Characterised by using a flexible or folded printed circuit (H05K3/326 takes precedence.
H05K1/092	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Use of materials for the (conductive, e.g.) metallic pattern. Dispersed materials, e.g. conductive pastes or inks.
H05K1/097	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Use of materials for the (conductive, e.g.) metallic pattern. Inks comprising nanoparticles, i.e. inks which are sinterable at low temperatures.

METHOD

Number	Description
H05K1/118	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Printed elements for providing electric connections to or between printed circuits. Specially for flexible printed circuits, e.g. using folded portions.
H05K1/038	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Use of materials for the substrate. Textiles (used as reinforcing materials for organic insulating substrates H05K1/0366).
H05K1/036	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Use of materials for the substrate. Multilayers with layers of different types.
H05K1/0393	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Use of materials for the substrate. Flexible materials (H05K1/038 takes precedence; specific organic compositions are classified in H05K1/0313 and subgroups).
H05K3/125	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Apparatus or processes for manufacturing printed circuits: Using: Thick film techniques, e.g. printing techniques to apply the conductive material {or similar techniques for applying conductive paste or ink patterns: By ink-jet printing.
H05K3/1216	Electric techniques not otherwise provided for printed circuits; casings or constructional details of elec-ric apparatus; manufacture of assemblages of electrical components Apparatus or processes for manufacturing printed circuits: Using: Thick film techniques, e.g. printing techniques to apply the conductive material or similar techniques for applying conductive paste or ink patterns: By screen printing or stencil printing.
H05K3/1233	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Apparatus or processes for manufacturing printed circuits: Using: Thick film techniques, e.g. printing techniques to apply the conductive material or similar techniques for applying conductive paste or ink patterns. Methods or means for supplying the conductive material and for forcing it through the screen or stencil.
H05K3/1241	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Apparatus or processes for manufacturing printed circuits: Using: Thick film techniques, e.g. printing techniques to apply the conductive material or similar techniques for applying conductive paste or ink patterns: By ink-jet printing or drawing by dispensing.

METHOD

Number	Description
H01B1/14	Basic electric elements Conductors or conductive bodies characterised by the conductive materials; Selection of materials as conductors (resistors H01C; selection of materials for superconductivity H01L39/00): Conductive material dispersed in non-conductive inorganic material.
H01B1/16	Basic electric elements Conductors or conductive bodies characterised by the conductive materials; Selection of materials as conductors (resistors H01C; selection of materials for superconductivity H01L39/00): The conductive material comprising metals or alloys.
H01B1/18	Basic electric elements Conductors or conductive bodies characterised by the conductive materials; Selection of materials as conductors (resistors H01C; selection of materials for superconductivity H01L39/00): The conductive material comprising carbon-silicon compounds, carbon or silicon.
H01B1/20	Basic electric elements Conductors or conductive bodies characterised by the conductive materials; Selection of materials as conductors (resistors H01C; selection of materials for superconductivity H01L39/00): Conductive material dispersed in non-conductive organic material {(organic macromolecular compounds or compositions C08).
H05K1/0283	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits Bending or folding regions of flexible printed circuits (H05K1/0283 takes precedence): Stretchable printed circuits.
H05K1/162	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Incorporating printed electric components, e.g. printed resistor, capacitor, inductor: Incorporating printed capacitors.
H05K1/165	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Incorporating printed electric components, e.g. printed resistor, capacitor, inductor: Incorporating printed inductors.
H05K1/167	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Incorporating printed electric components, e.g. printed resistor, capacitor, inductor: Incorporating printed resistors.
H05K1/0283	Electric techniques not otherwise provided for printed circuits; casings or constructional details of electric apparatus; manufacture of assemblages of electrical components Printed circuits: Bending or folding regions of flexible printed circuits (H05K1/0283 takes precedence): Stretchable printed circuits.

Source: Website of PatSnap.

METHOD

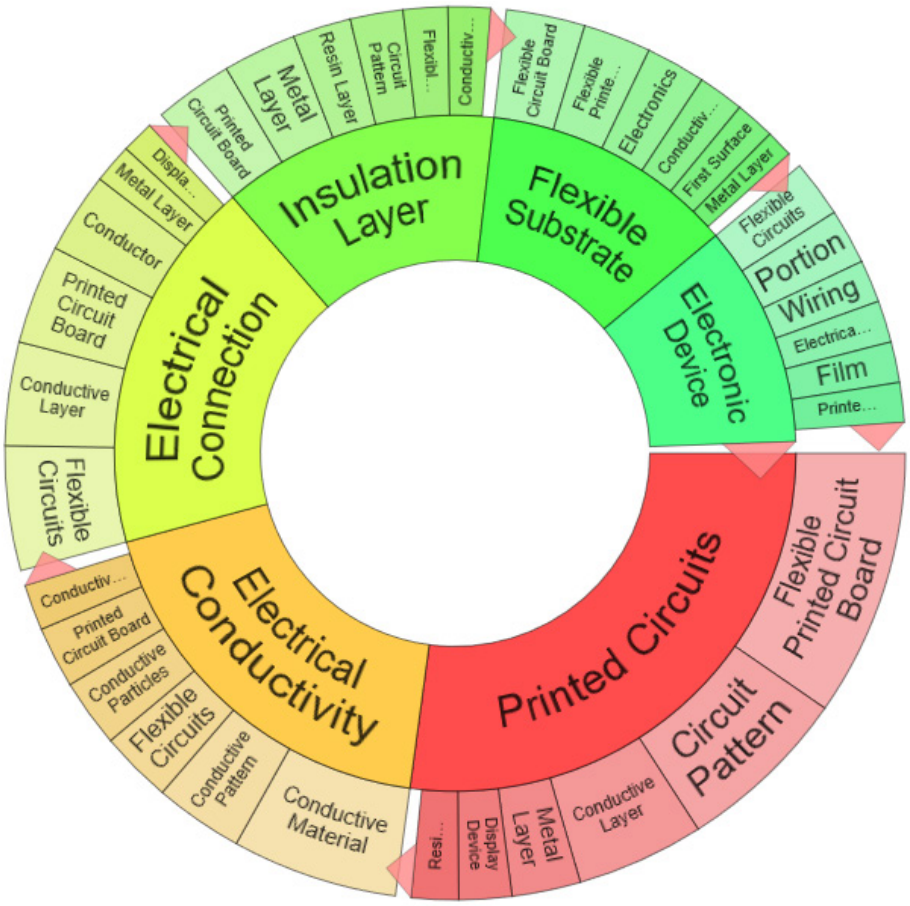
Our patent search identified 16,537 patent families from 2010-2018 of high technological relevance to this study.

We have captured the group of patent families by using CPC-codes because it is a more precise search for patents rather than using keywords such as 'printed electronics'. The challenge when using key words in the patent search is that printed electronics is an all-encompassing term for the printing meth-od. Given that printed electronics is a method and patents rarely mention the specific method in the patent description, it is not a satisfactory way of searching for printed electronics related products. Moreover, printed electronics technologies have different names such as flexible printed circuits and stretchable printed circuits. There are no conventions that can be followed, and some patents may be relevant to printed electronics but without mentioning related words. Thus, it is not enough just to search for printed electronics. Therefore, we have used CPC-codes to identify the most relevant patents that include technologies related to printed electronics.

However, the wheel of innovation indicates that the identified patents represent technologies that are all related to printed electronics, see Figure 12. 'Printed circuits' and 'electrical conductivity' are the two most frequent keywords when it comes to printed electronics patents, each with a number of keywords, including applications and specifications attached to them. 'Flexible printed circuit board' is the most frequently used keyword in the second tier of the wheel and 'Metal Layer' and 'printed circuit' are keywords that occur under many of the first tiers of the wheel indicating a strong relationship between the key words in the first layer.

Overall, we assume and are confident that our patent search related to printed electronics is providing us with solid data. Through validating the search in the wheel of innovation we believe that the group of patents is sufficient to make an overall strategy analysis of the technological developments within printed electronics. The data base can also be used as a point of departure for more focused patent searches within more specific technological areas.

FIGURE 12: WHEEL OF INNOVATION, KEY TECHNOLOGIES WITHIN PRINTED ELECTRONICS



The Circle Chart categorizes the most frequent keywords in identified patents into a 2-tier hierarchy of within the most recent 10,000 Simple Families in the technology field.

Source: PatSnap, processed by Danish Technological Institute

In this report, Danish Technological Institute dives into global databases with patent data to gain a better understanding of the potential of the printed electronics. This kind of patent mapping provides insight into identifying trends and patterns in the data. The purpose of the report is to use the data to gain strategic insight into technologies, actors, and markets.

By carrying out a patent mapping focused at printed electronics, we offer companies a global strategic overview of trends within printed electronic. The patent mapping gives an indication of the key technological areas and the leading knowledge centres (companies/research institutes and their geographical distribution). Such a global patent mapping can only provide companies with overall strategy business information. If a company initiates innovation within a specific technological field of printed electronics, we recommend that they request a focused patent mapping which can provide them with more relevant information and an indication of 'license to operate' with respect to existing patents.

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