Patent Searching | Research and Analytics | Patent Filing | Prosecution | Litigation and E-Discovery | IP Valuation | Patent Portfolio | Landscape

EXEMPLARY IP LANDSCAPE REPORT ON

FLEXIBLE DISPLAYS

Contents

1. Flexible Displays: A Revolutionary Breakthrough

Flexible displays, when they hit the market, will provide endless possibilities for design and innovation. For the major part of evolution of electronic display devices, displays device were confined to boundaries of simple flat pieces of glass or plastics and dictated the design of technology. However, in recent times, engineers together with manufacturers are coming along with advanced versions of displays such as Curved Screens, OLEDs, and Notch Display among others; more and more of which can be found on computer monitors, televisions and smart phones.

In addition to this, smart phone industry leaders such as Samsung, Apple, and LG have showcased devices with advanced displays. For example, Samsung Galaxy S7 Edge and LG G Flex are some of the advanced devices featuring flexible displays.

With flexible display devices, manufacturers are coming with yet another effort to advance the technology. In fact, flexible displays have the potential to become one of the biggest technological breakthroughs for the decade---encouraging designers to create devices that we have never seen before.

So, what exactly is a flexible display and why do technology majors around the world see it as the next big thing? Let's check out.

Flexible does not mean curved

Although curved screens are impressive, they are not the same as the ones that are bent. Traditionally liquid-crystal displays (LCDs) are sandwiched with materials that include backlight, polariser, thin-film transistor, liquid crystals, and filter glass. LCDs are usually flat, but several companies like Samsung have managed to produce curved LCDs.

The recently released organic LED ecosystem (OLED) has gained popularity; thanks to its simplified design, better image quality and flexibility. OLED displays do not require backlighting, so these can be thinned and moulded into specific shapes such as the curved display on Samsung Galaxy S7. Flexibility, thinness, and excellent image quality make OLED

a better choice for curved screens. It is evident that the OLED will overthrow LCD TVs in the future. That said, the OLEDs are currently too expensive to produce for large screens such as televisions and computer monitors.

Although LCDs contain more layers than OLEDs, these screens may still be bent. Apple Japan Display is developing a 14cm (5.5-inch) full HD LCD. The display will use plastic for the substrate that is traditionally been made of non-removable glass. This will enable it to flex and bend.

Nonetheless, engineers need to come up with a way to create materials that will not break down under repeated bending stress, keeping a consistent image on the screen. Sure, this is a huge challenge.

Durability is a huge plus point in Flexible Displays

The biggest advantage of flexible displays is durability as screens can be bent and manipulated, besides it can absorb phyisical impact better than the solid glass structures currently prevailed in the art. As a consequence, broken display screens will become a thing of the past. Sure, it will take some time before we reach that point of display evolution. It is assumed today that flexible screens will use plastic instead of glass, but the plastic itself can still crack under extreme stress.

Therefore, manufacturers are coming up new material. Such as 'Corning' is currently working on a flexible glass called 'Willow', which is planned to be put into everything, including phones, televisions to etc. Willow is as thin as a piece of paper and is bendable.

Smartphone biggies (Samsung, Apple, and LG) has joined the move

The three largest mobile manufacturers are reportedly experimenting with flexible displays. According to Samsung, the most important feature of Galaxy X is that its display can be folded outside, allowing users to convert their phones into 12.7cm (7-

inch) tablets. LG is also said to have come out with a smart-phone that folds outside; to form a tablet. A Patent applicationfiled by LG depicts a conceptual LG phone that has a foldable display, and which can be used even after full bending. Apple is considering the use of flexible displays on the iPhone in 2018.

Sources:https://electronicsforu.com/technology-trends/tech-focus/flexible-displays-revolution

Growth Prospects of Flexible Display & some of its Potential Applications

Other technologies could also benefit from flexible displays. For example, flexible displays could be used as clothing that changes colour or pattern instantly as per the environment, making these particularly useful for soldiers, for example.

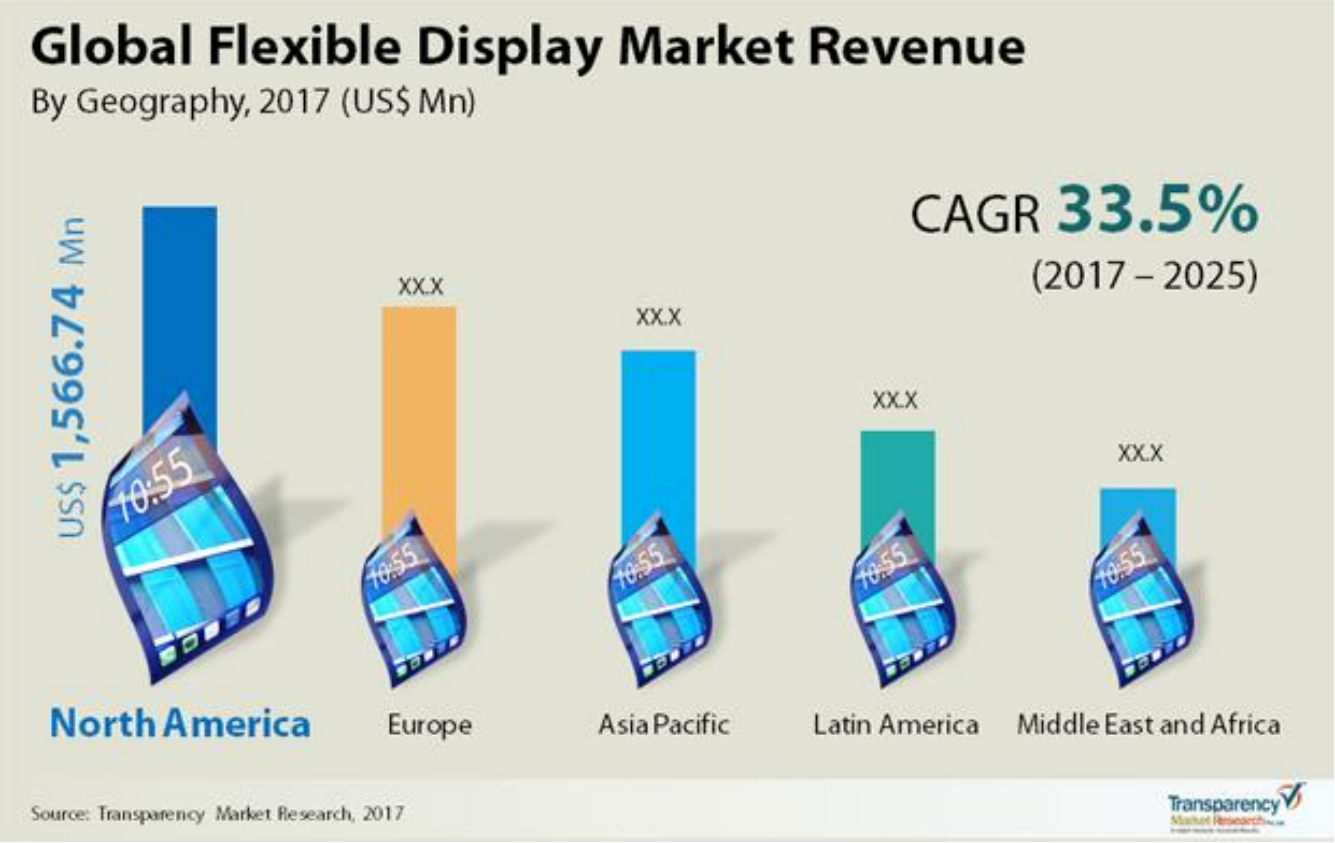
[Source]

Increasing Demand for Flexible Display in Various Electronic Gadgets to Benefit Market Growth

Key players in the global flexible display market are capitalizing on their growth by using business development strategies. Leading players are involved in mergers and acquisitions, which is considered one of the key strategy for growth and expand geographical reach. These players are also planning to expand their product line by introducing new products. To name some of the prominent players in the global

flexible display market, Koninklijke Philips N.V., Samsung Electronics Co. Ltd., Atmel Corporation, Universal Display Corporation, and Panasonic Corporation are among some of the prominent ventures.

According to the Transparency Market Research, the global flexible display market is expected to rise at a healthy growth rate of 33.5% between 2017 and 2025. With this, the market is projected to reach a valuation of US$47.8 bn by the end of 2025



[Source]

Based on form factor, the demand in curved display is much higher than compared to other form factors. Curved display appeals to the users besides providing the viewer with optimal visual experience. The curved display provides undistorted and vivid images.

Based on geography, North America leads the market due to the presence of prominent manufacturers in the region. On the other hand, Asia Pacific is also expected to rise at 39.3% CAGR, thus making it one of the key region for growth of this market.[Source]

2. OBJECTIVES

- To perform detailed analysis of granted patents and published patent applications pertaining to Flexible Displays and to understand underlying technologies.

- In depth analysis of patents/applications in order to categorize them and to understand focussing areas of applicants.

- Graphical representation of trends (Filing, Publication, etc.) from mined data of relevant patents/applications.

Image Courtesy

Image Courtesy

3. SEARCH METHODOLOGY

The first step is to create and define a patent set that will serve as the basis of analysis. Using renowned patent database Thomson Innovation (TI) as our data source, we used following search query to retrieve our dataset.

Search was carried out in Abstract, Title, and Claims fields of a patent, by using keywords andInternational Patent Class.

4. EXECUTIVE SUMMARY

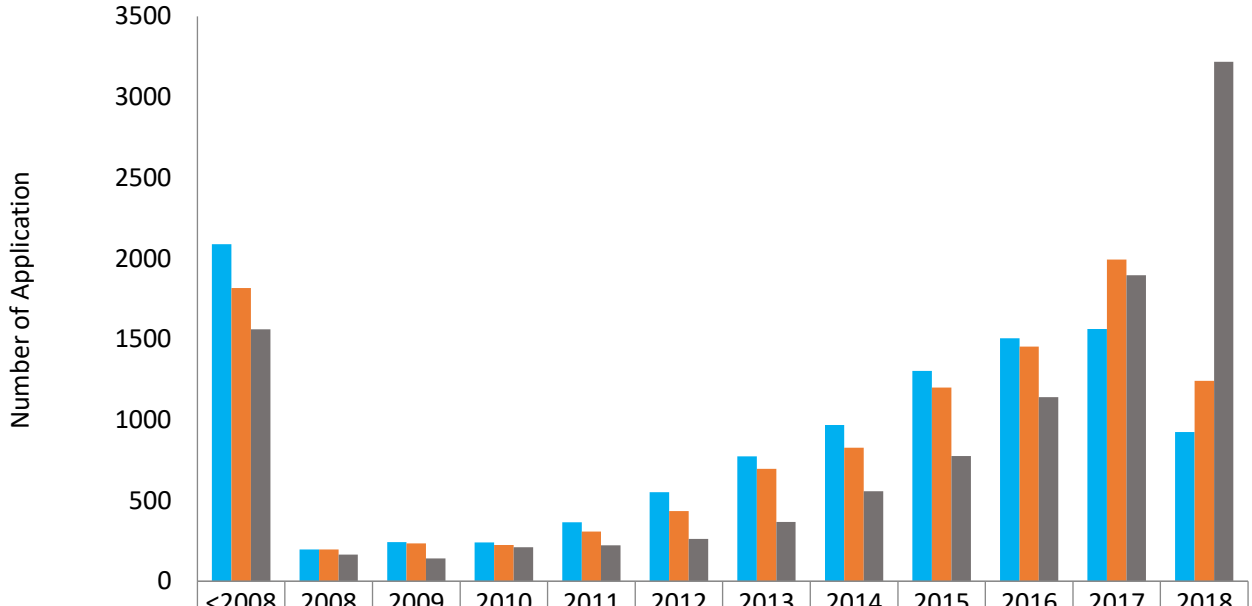
- A set of 10657 patent families, filed till 2018 in the field of Flexible Displays, were analysed. A total of 20590 individual patents/applications forms parts of these patent families.
- This report explores patent landscape of Flexible Displays for worldwide patent/applications filed till the year **2018**.
- In last four years, there is a rise in patent filing activities for Flexible Display. Year 2017 has witnessed maximum patent application filings.
- Samsung (1069 patent families) is the world leader among patent applicants, followed by LG (696 patent families). Other applicants having significant quantity of patent application filings are Boe Technology Group Co Ltd , Oppo, Nubia Technology Co Ltd,Universal Display Corp, and Lenovo among others.
- Inventors from China, Lin Yu-Gui followed by Kim Hyun-Jin, and Lee Gunho are among the leaders in innovations in Flexible Display. Huitema, Kang Kyung and Cheng-Jiao had too contributed significantly.
- China registers itself as the highest innovation country. Over 4548 patent families were filed in China itself; followed by Korea with 2877 patent families .
- China leads as the country with highest number of individual/foreign patent application filings i.e. China is the country of interest for innovators with 6830 patent applications, followed by United State 5860 patent applications.
- From the total set of 10657 patent families, a limited set of 645 patent families, pertaining to patent application filed in the year 2017-2018 were analysed in depth, wherein it was found that various solutions are provided by innovations for Flexible Display, the main focus lies in providing solution for Display Structure/Packaging.
- From the total set of 10657 patent families, a limited set of 645 patent families, pertaining to patent application filed in the year 2017-2018 were analysed in depth, wherein it was found that patent applications that focussed on application of flexible displays are Mobile phones or Laptop (37%), Television Devices (21%), wearable Devices (14%), and E-book/E-paper (11%), and Navigation Devises (8%)among others.

5. NON-TECHNICAL ANALYSIS

5.1 PRIORITY, FILING, PUBLICATION YEAR BASED TREND ANALYSIS

5.1.1 ANALYSIS BASED ON REPRESENTATIVE MEMBER PER FAMILY

Below graph represents trends for priority year, application year, and publication year based on the patents/patent applications pertaining to Flexible Displays.



	<2008	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Priority Year	2089	197	242	241	365	553	775	969	1303	1506	1563	925
Filing Year	1816	198	235	225	309	435	697	827	1200	1454	1994	1242
Publication Year	1562	165	142	212	224	262	368	559	777	1141	1896	3218

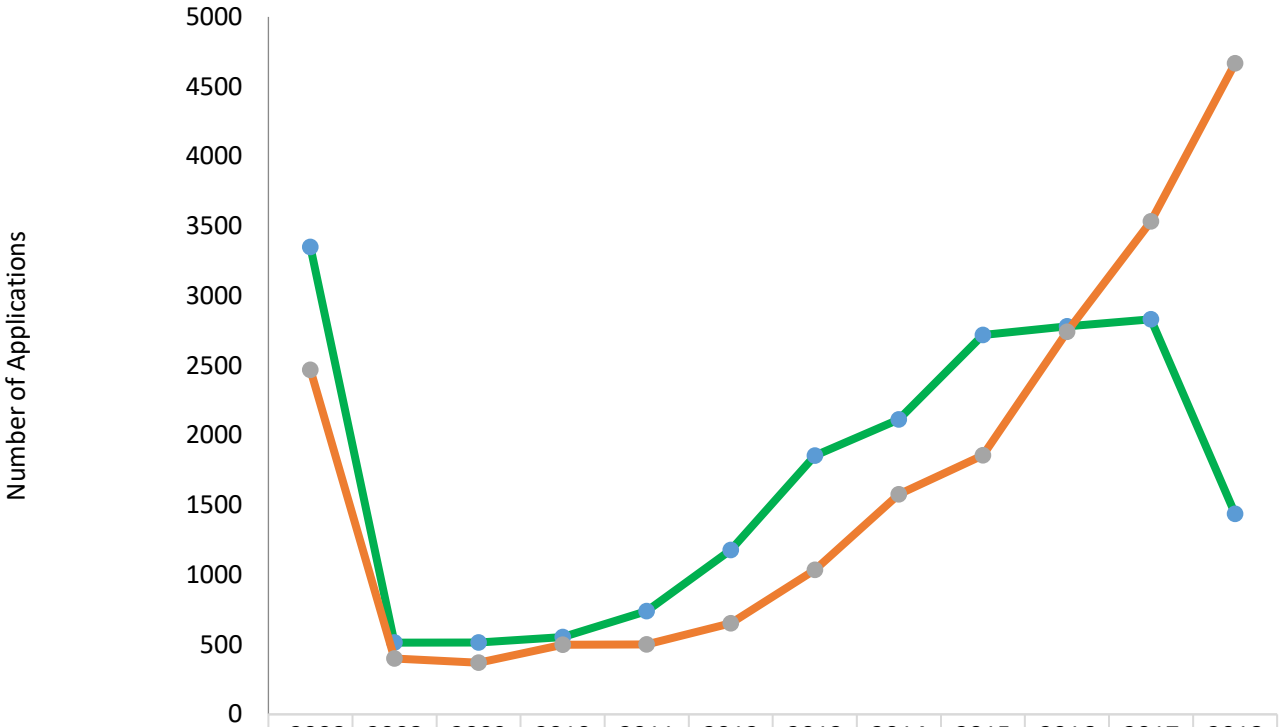
Note: There may be higher number of application for year 2015-2018, attributed to non-published patent applications.

INSIGHT:

- Priority trend provides insights for the first filing years. As represented in the graph, there is a gradual increase in the number of application being filed or claiming priority of previously filed applications. Maximum number of patent applications claiming priority from the years **2015-2018.**
- Filing year trend provides insights for the number of applications filed in a particular year. As indicated in the graph, there is a gradual rise in patent applications filing over the years, wherein maximum numbers of patent applications were filed in the years **2015-2018.**
- Publication trend provides insights for the number of applications published in a year. As indicated in the graph, there is a gradual rise in publication over the years, wherein maximum numbers of patent applications were published in the years **2016-2018.**

5.1.2 FILING AND PUBLICATION TREND ANALYSIS (BASED ON EXPANDED FAMILY BASED DATA)

Below graph represents application year v/s publication year comparison trends.



	<2008	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Application Year	3350	514	516	554	740	1179	1854	2115	2719	2781	2832	1436
Publication Year	2470	401	370	498	502	652	1036	1577	1857	2743	3535	4667

Note: There may be higher number of application for year 2015-2018, attributed to non-published patent applications.

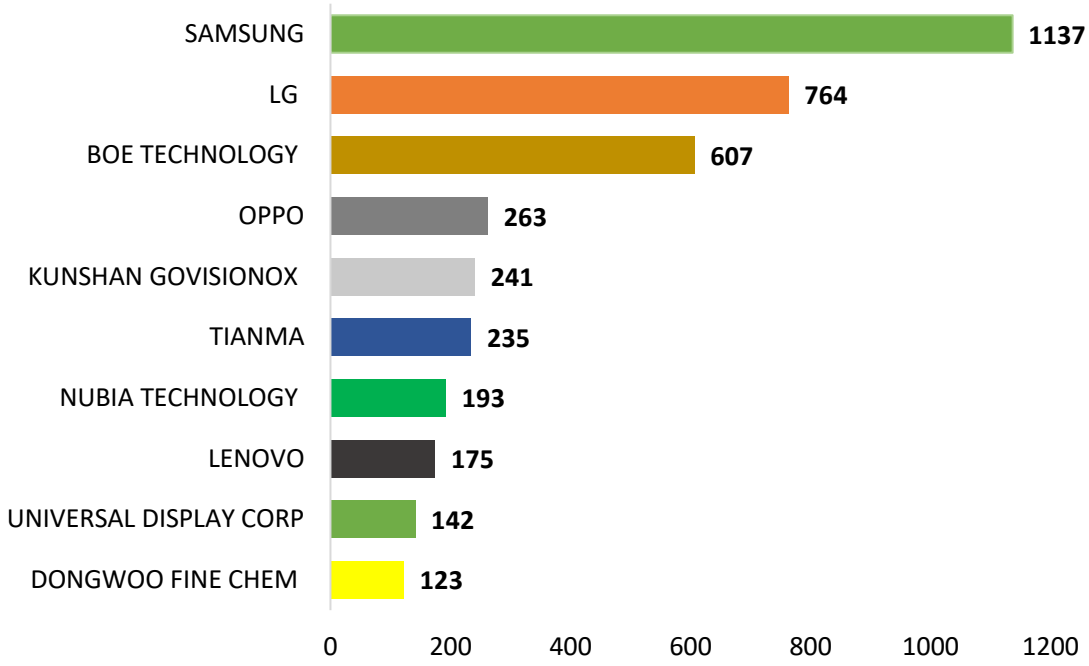
INSIGHT:

- As evident from the comparison trend, there is continuous rise in the number of patent application filing and patent application publication, over the period of time. Maximum number of applications (2832) were filed in 2017 and maximum number of application were published (4667) in 2018.

5.2 ASSIGNEE BASED TREND ANALYSIS

5.2.1 MAJOR ASSIGNEES (BASED ON REPRESENTATIVE MEMBER PER FAMILY)

Below graph represents trend for major assignees.



Note: There may be higher number of application for year 2015-2018, attributed to unpublished

INSIGHT:

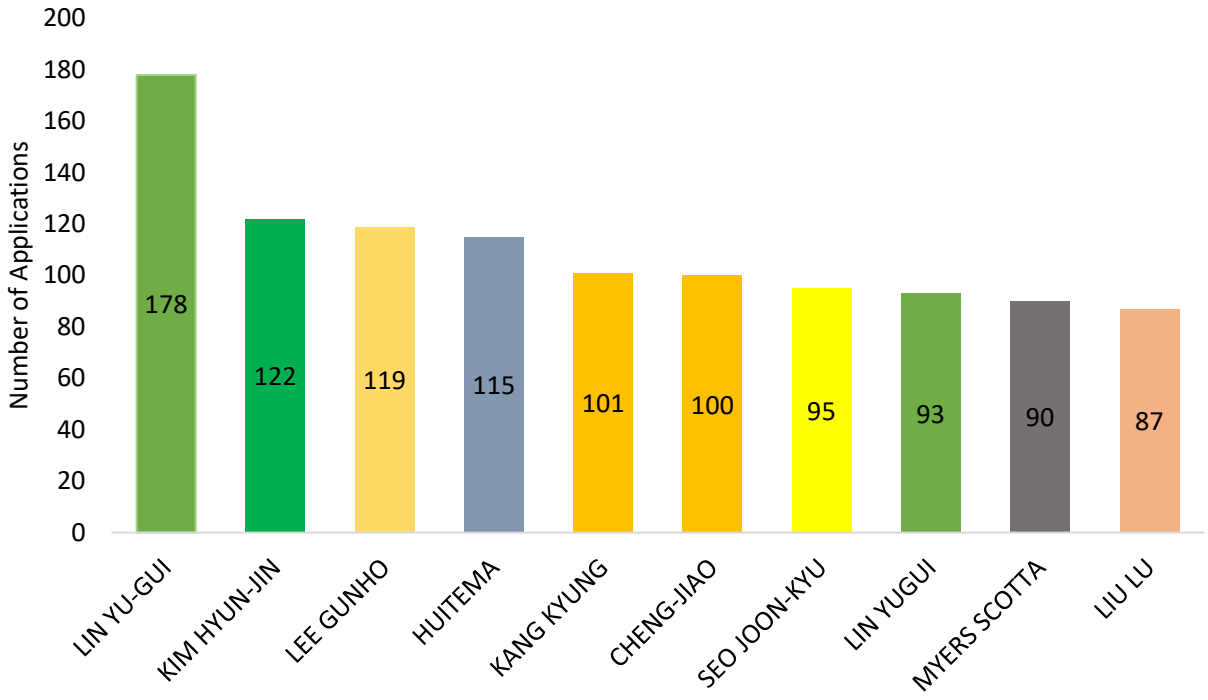
As evident from the data, Samsung is world leader in filing patent application pertaining to flexible displays. The trend is followed by LG and BOE Technology as the next two top assignees.

THE TOP ASSIGNEES ARE:

- SAMSUNG
- LG
- BOE TECHNOLOGY
- OPPO
- KUNSHAN GOVISIONOX
- NUBIA TECHNOLOGY
- LENOVO
- UNIVERSAL DISPLAY
- DONGWOO FINE CHEM
- TIANMA MICROELECT.

5.3 KEY INVENTORS

Below graph represents trends for top inventors.



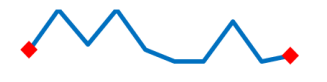
Note: There may be higher number of application for year 2015-2018, attributed to unpublished

INSIGHT:

Lin Yu-Gui (178), Kim Hyun-Jin(**122**) and Lee Gunho(**119**) are the top three innovators that are prominently contributing to the innovations happening in the Flexible Display domain. In addition, the trend shows that Huitema (**115**), Kang Kyung (101) and Cheng-Jiao(**100**) have made recognizable contribution in the domain.

5.4 KEY STATISTICS–MAJOR ASSIGNEES

Concise summary for major patent applicants.

Assignee	Total No. of Records	Filing Trend (Last 10 years)	Key Inventor (Top 5)	Coverage (Includes families)							
				US	EP	WO	JP	KR	CN	AU	IN
Samsung	1137		Kang Kyoung Ku | Lee Junghun | Choi Kyungmin | Kim Min Hye | Lee Jusuck |	77	4	1	4	987	7	1	1
LG	764		Lee Doyoung | Chun Sinae | Kwon Seyeoul | Kim Jihwan | Youn Sangcheon |	36	1	15	9	639	3	0	0
BOE tech.	607		Cai Baoming | Chen Liqiang | Bu Dejun | Li Jianwei | Zhang Song |	2	0	3	0	0	595	0	0
OPPO	263		Lin Yugui | Cheng Jiao | Zhang Haiping | Chen Jia | Yang Le |	0	0	0	0	0	263	0	0
Nubia tech.	241		Li Chunbao | Liao Meng | Liu Gan | An Bangjun | Yang Zhanglin |	0	0	0	0	0	193	0	0
Kunshan govisionox optoelectronic	235		Huang Xiuqi | Cai Shixing | Bu Fanzhong | Guo Rui | Xu Lei |	0	0	0	0	0	186	0	0
Tianma	193		Zhai Yingteng | Yu Quanpeng | Leng Chuanli | Liu Conghui | Li Xilie |	0	0	0	0	0	178	0	0
Lenovo	175		Xu Ben | Zuo Changlong | Fan Xiaoli | Zhang Ran | Ma Lei |	7	0	0	9	0	159	0	0

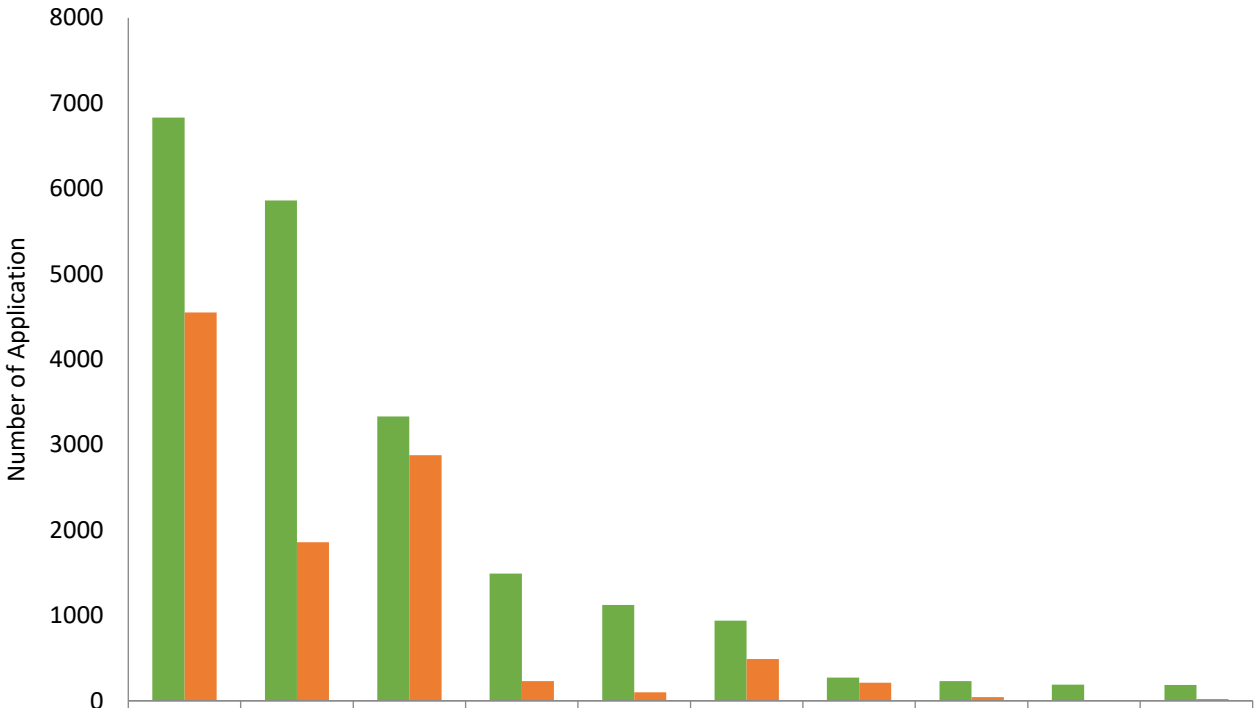
Universal display corp	142		Wolohan Peter | Ji Zhiqiang | Tsai Jui-Yi | Feldman Jerald | Fitzgerald George |	139	0	1	2	0	0	0	0
Dongwoo fine chem co ltd	123		Lee Seung Woo | Choi Hanyoung | Lee Seungwoo | Yang Min Soo | Yu Byungmuk |	0	0	0	0	123	0	0	0

Note: There may be higher number of application for year 2015-2018, attributed to unpublished

5.5 GEOGRAPHY BASED TREND ANALYSIS

5.5.1 PRIORITY V/S APPLICATION FILING TREND ANALYSIS (Based on Expended Patent Family)

Below trends relates to priority countries v/s foreign filing countries



	CN	US	KR	WO	EP	JP	GB	AU	IN	CA
Filing	6830	5860	3329	1491	1124	940	272	230	190	185
Priority	4548	1858	2877	231	99	488	213	42	10	21

INSIGHT:

Maximum numbers of patent applications were filed in China (Priority **4548,** Application **6830**) Followed by US (Priority **1858,** Application **5860**), Korea (Priority **2877,** Application **3329**). Samsung and LG are among the top applicants originating from **Korea,** BOE Technologies is among top assignee from **China.**

5.5.2 GEOGRAPHICAL ORIGIN TREND ANALYSIS

Below graph depicts trends for priority country v/s priority filling years.

Priority Year → / Priority Country ↓	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	<2008	Total
CN	890	1253	762	549	359	197	130	87	54	66	34	167	4548
KR	20	119	478	543	389	425	282	149	106	86	69	211	2877
US	1	87	126	124	107	78	78	81	45	38	43	1050	1858
JP	4	25	41	28	40	32	32	16	20	22	19	209	488
WO	0	28	81	29	36	15	7	6	5	2	3	19	231
GB	0	1	4	9	5	8	3	3	2	9	9	160	213
TW	3	5	12	12	19	14	21	25	18	23	11	27	190
EP	0	1	3	12	7	6	7	10	8	4	1	40	99
DE	0	3	2	8	8	5	3	2	0	4	2	61	98
FR	0	0	1	0	2	1	0	4	1	1	2	43	55
Total	918	1522	1510	1314	972	781	563	383	259	255	193	1987	10657

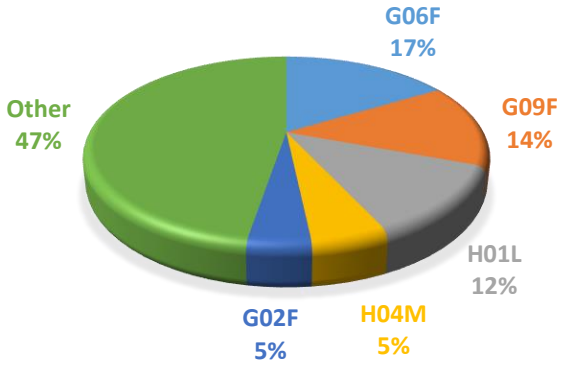
Note: There may be higher number of application for year 2015-2018, attributed to non-published applications.

INSIGHT:

Maximum numbers of innovations were originated from China (Priority Applications **1253**) in the year of 2017, wherein the total numbers of innovations from China are 4548. Korea has **543** priority applications in the year of 2015 and 2877 nos. of patent applications in totality. US, on the other hand has **126** priority applications in the year of 2016 and 1858 nos. of patent applications in totality. Samsung and LG are among the top assignees, which originate from **Korea**, BOE Technology is among top assignee from **US**.

5.6 INTERNATIONAL PATENT CLASSIFICATION BASED TREND

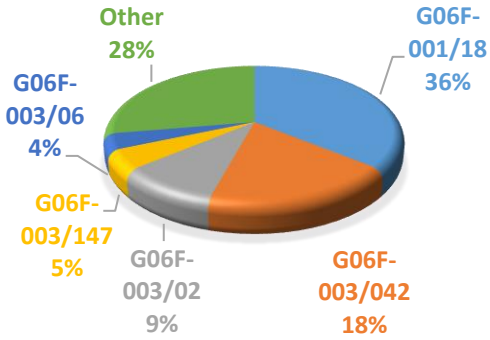
Below graph represents top international patent classes pertaining to Flexible Display .

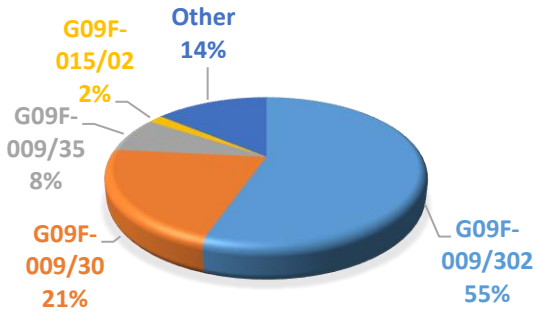


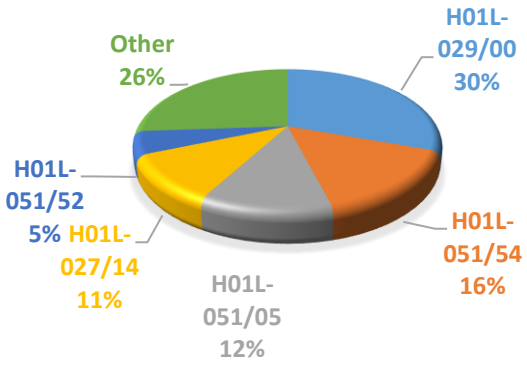
INSIGHT:

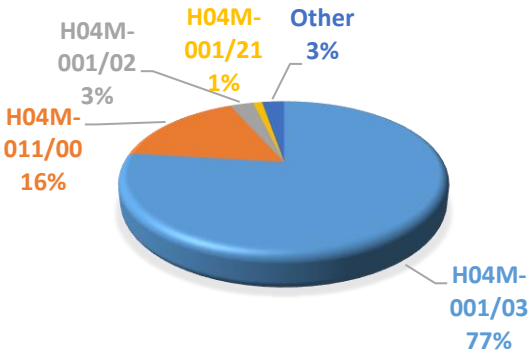
Majority of patent applications were assigned with IPC "G06F" followed by "G09F".

5.6.1 INTERNATIONAL PATENT SUB-CLASSIFICATION BASED ANALYSIS









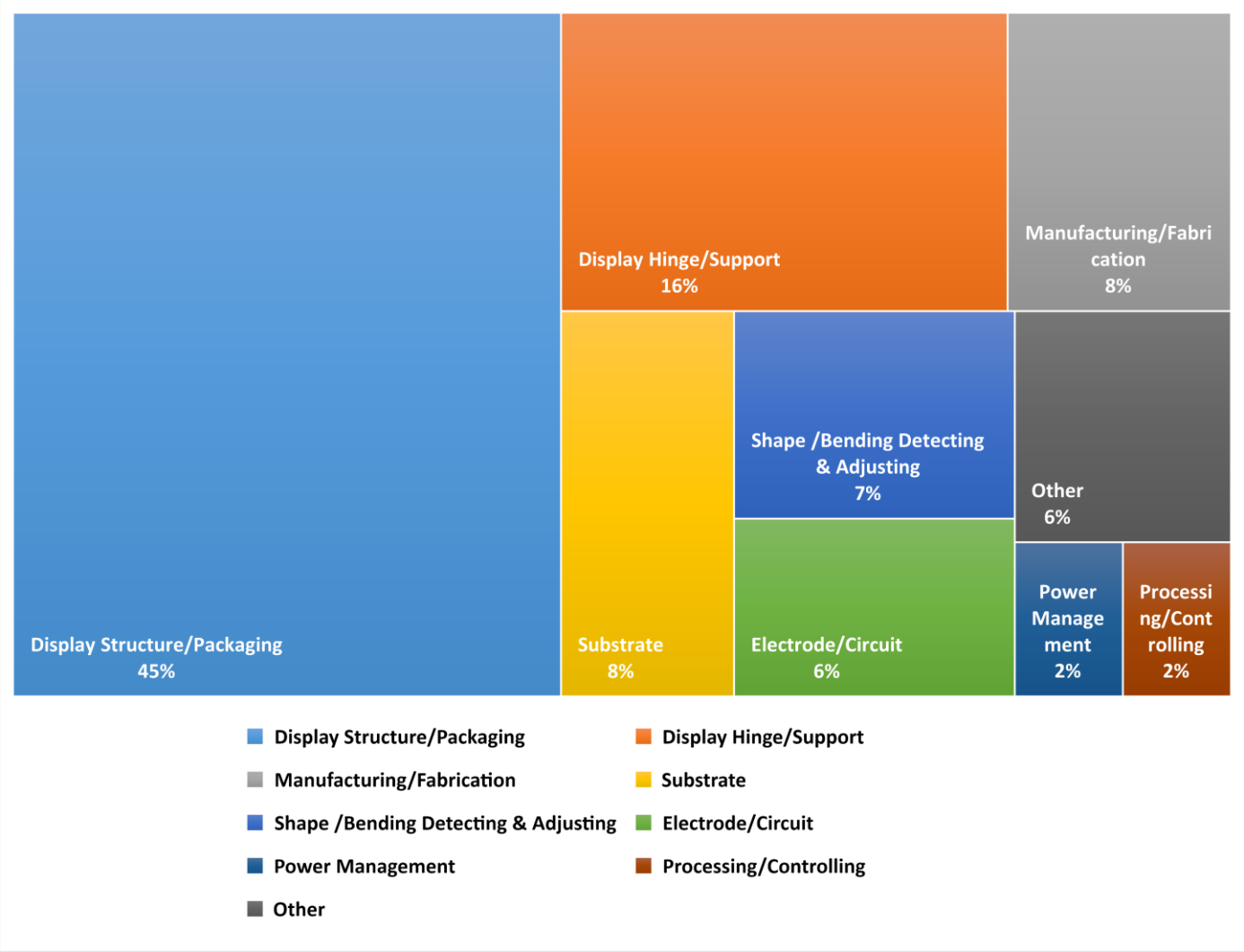
IPC DEFINITIONS:

IPC Subclass	Definition
G09F	Displaying; advertising; signs; labels or name-plates; seals
G09F-009/00	Indicating arrangements for variable information in which the information is built-up on a support by selection or combination of individual elements (in which the variable information is permanently attached to a movable support G09F 11/00)
G09F-009/302	characterised by the form or geometrical disposition of the individual elements
G09F-009/30	in which the desired character or characters are formed by combining individual elements
G09F-009/35	being liquid crystals
G09F-015/02	Bills, posters, or the like therefor
G06F	Electric digital data processing
G06F-001/18	Packaging or power distribution
G06F-003/00	Input arrangements for transferring data to be processed into a form capable of being handled by the computer; Output arrangements for transferring data from processing unit to output unit, e.g. interface arrangements [2006.01]
G06F-003/042	by opto-electronic means
G06F-003/02	Input arrangements using manually operated switches, e.g. using keyboards or dials
G06F-003/147	using display panels
G06F-003/06	Digital input from, or digital output to, record carriers
H01L	Semiconductor devices; electric solid state devices not otherwise provided for
H01L-029/00	Semiconductor devices specially adapted for rectifying, amplifying, oscillating or switching and having at least one potential-jump barrier or surface barrier; Capacitors or resistors with at least one potential-jump barrier or surface barrier, e.g. PN-junction depletion layer or carrier concentration layer; Details of semiconductor bodies or of electrodes thereof
H01L-051/00	Solid state devices using organic materials as the active part, or using a combination of organic materials with other materials as the active part; Processes or apparatus specially adapted for the manufacture or treatment of such devices, or of parts thereof
H01L-051/54	Selection of materials
H01L-051/05	specially adapted for rectifying, amplifying, oscillating or switching and having at least one potential-jump barrier or surface barrier; Capacitors or resistors with at least one potential-jump barrier or surface barrier
H01L-051/52	Details of devices
H01L-027/14	including semiconductor components sensitive to infra-red radiation, light, electromagnetic radiation of shorter wavelength or corpuscular radiation and specially adapted either for the conversion of the energy of such radiation into electrical energy or for the control of electrical energy by such radiation
H04M	Telephonic communication
H04M-001/00	Substation equipment, e.g. for use by subscribers
H04M-001/03	Constructional features of telephone transmitters or receivers, e.g. telephone hand-sets
H04M-001/02	Constructional features of telephone sets
H04M-001/21	Combinations with auxiliary equipment, e.g. with clocks or memoranda pads
H04M-011/00	Telephonic communication systems specially adapted for combination with other electrical systems
G02F	Devices or arrangements, the optical operation of which is modified by changing the optical properties of the medium of the devices or arrangements for the control of the intensity, colour, phase, polarisation or direction of light, e.g. Switching, gating, modulating or demodulating; techniques or procedures for the operation thereof; frequency-changing; non-linear optics; optical logic elements; optical analogue/digital converters

6. TECHNICAL TREND ANALYSIS

6.1 FOCUS OF INVENTIONS

A set of 645 patents or patent applications, filed during last two years (2017-2018), were analyzed in depth to identify focus of the patents/patent applications.



INSIGHT:

Maximum numbers of patent/patent applications discuss innovations related to Display Structure/Packaging (**45%**), followed by Display Hinge/Support (**16%**).

6.2 APPLICATION BASED DISTRIBUTION OF PATENTS

A set of 645 patents or patent applications, filed during last two years (2017-2018), were analyzed in depth to identify application of the patents/patent applications in industries.

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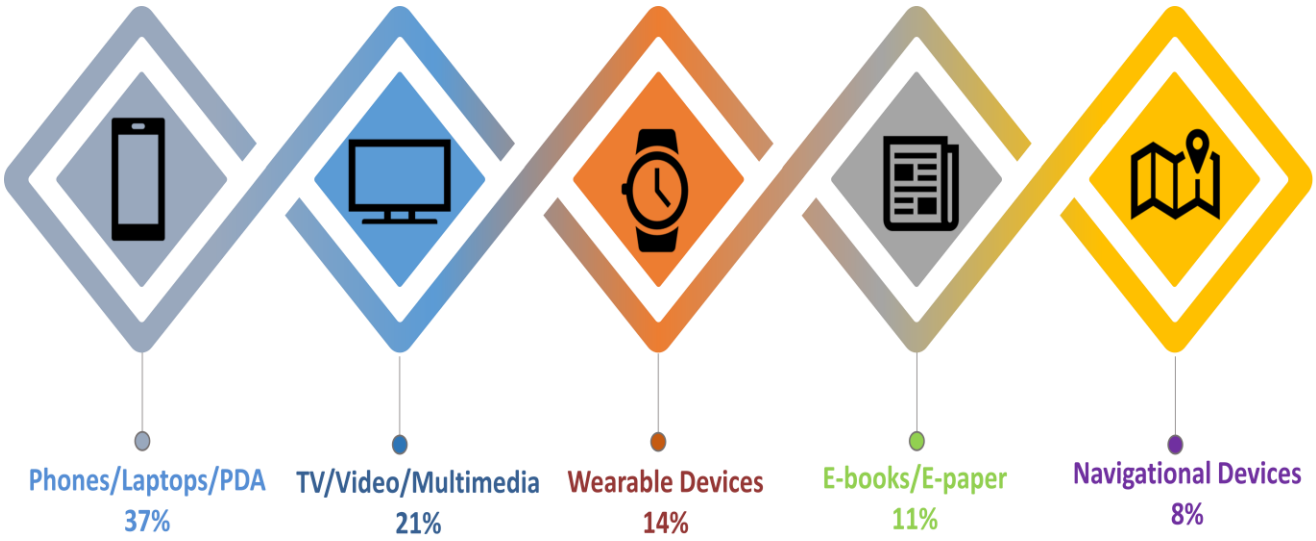

Note: There may be higher number of application for year 2017-2018, attributed to unpublished

Other Applications
Digital Photo Frames (6%), Digital Camera (2%), Gaming Devices (1%), Advertising Device (1%), Medical/Surgical instruments (1%), Smart Cards (1%) and Generic (52%)

INSIGHT:

Maximum numbers of patent/patent applications discuss application of flexible display in Phone/ Laptop or PDA **(37%),** TV/Video/Multimedia **(21%),** followed by wearable devices (**14%**) applications.

7. Final Submission

- A set of 10657 patent families, filed till 2018 in the field of Flexible Displays, were analysed and detailed analysis is presented *Supra*.

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