Analysis of curved display technology patents

Dani Kim, Principal Analyst, + 82 (0)31 704 7188, Dani.Kim@ihs.com
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I. Analysis overview
1. Analysis background

The 2013 International CES, a global home appliances exhibition, was the arena of competition among next-generation TVs, particularly between Samsung Electronics Co. and LG Electronics Inc. The two South Korean tech giants took the center stage with their own curved organic light-emitting diode (OLED) TVs. In particular, LG Electronics presented its new product, named Curved 3D OLED TV. The company emphasized that the curved OLED TV is a product of the state-of-the-art technology that allows no screen distortion just like when watching an IMAX movie, thanks to the inwardly curved screen.

LG Electronics released the world’s first 55-inch curved OLED TV in April, and two months later Samsung Electronics held a presentation on its strategic TVs for the second half of 2013 where it emphasized the “zero pixel defect (ZPD),” heating up the competition on curved OLED TV between the two companies.

On top of that, Samsung released the Galaxy Round, a smartphone with a curved screen, for the first time in the world. LG Electronics is also planning to release such a kind in November, showing that a curved display is rapidly spreading also in the smartphone market. Smartphone displays have evolved from black-and-white LCD, to color TFT-LCD, active matrix (AM) OLED and to curved display, heralding the competition over the next-generation smartphone display market.

IHS timely published a key patent report on curved displays that contains both curved OLED and curved LCD. This report selected related patents applied in South Korea, Japan, the United States and Europe, and under the Patent Cooperation Treaty (PCT) to analyze patent application trends and patents from major companies. It also extracted key patents from the already selected patents for an in-depth analysis. This report should be of a great help in better understanding general technology development trends in the curved display market and key patented technologies.
2. Analysis methodology

This report covers curved display technology. It targets patents published and issued until 28 August 2013 in South Korea (KR), Japan (JP), the United States (US), and Europe (EP), and under the PCT (WO). A total of 202 curved display related patents were extracted and sorted out into three technologies—curved OLED, curved LCD, and others. A quantitative analysis was made on the 202 patents, seeking for the global patent application trends. Of which, 54 US and PCT patents were selected as the key patents for an in-depth analysis. For reference, a list of the 202 patents is included at the end of this report (See Appendix).

Scope and method of analysis

1. Patent research scope
   - Research period: ~ 28 August 2013
   - Patent search DB: Focust, USPTO

2. Patent application trends (202 patents)
   - Patent research and noise removal
   - Technology classification and selection of related patents
   - Quantitative analysis by year/technology/assignee

3. Key patent analysis (54 patents)
   - Key patent selection (US, PCT)
   - Analysis of technology development trends
   - Analysis of key patent abstract and embodiments

4. Conclusion
   - Summary of patent application trends
   - Patent competitiveness by major company
   - Conclusion/Implications

Notes: Major search keywords are curved display, curved OLED, and curved LCD.
Source: IHS

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3. Use of patent information

Patent information is disclosed to the public 18 months after the patent's application date. When well used, the information is expected to provide trends of related technologies and prior arts; to inspire new ideas; and to prevent patent disputes by identifying third parties’ claim.

Patent information use

Infringement Detection
Prior Art Search
Determination of R&D Direction
Prevention of R&D Repetition
Commercialization Review, etc.

Scope
Patent Information
Company Information
Technological Information
Legal Information

Use
Benefit

- Avoidance of Overlapping Investment
- Speed-up of R&D
- Acquisition of Valid Patent
- Invalidation of Competitor’s Rights
- Level-up of Engineer, etc.

R&D(Patent) Activities

Feasibility
- Prior Art Search
- Analysis (Patent Mapping)
- Patent Application Plan

R&D
- Patent Application (Acquiring)
- Project Patent Strategy
- Continuing Search (New Patent)

Commercialization
- Patent Portfolio (Competitiveness)
- Patent Strategy for Business
- Patent Issue Analysis

Source: IHS
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II. Technology overview
1. Curved display technology overview

A curved display is designed to allow the same distance between the viewer and every part of the screen, as if s/he is watching an IMAX movie. That is, unlike the conventional flat panel display, the distance from the eyes of the viewer to the center of the screen is the same with that to the sides of the screen. Hence, the screen distortion and the decrease in recognition of the sides, in which the ends of viewing angle grow dim, are minimized. This provides a comfortable viewing environment and gives immersion to the viewer.

Looking at the figure below, a curved display has a broader field of view (FoV) than a flat panel display even if the two have the same area. This is one of the major advantages of using a curved display. The viewer is provided with a broader FoV to feel greater immersion, along with greater amount of visual recognition thanks to the increased area of images seen.

Next slide looks into the trends in curved OLED and curved LCD, which came to the fore at CES 2013 and IFA 2013.
2. Trends in curved OLED

CES 2013, a global home appliances exhibition, was the arena of competition among next-generation TVs, particularly between Samsung Electronics and LG Electronics. The two South Korean tech giants took the center stage with their own curved OLED TVs. In particular, LG presented its new product, named Curved 3D OLED TV. The company emphasized that the curved OLED TV is a product of the state-of-the-art technology that allows no screen distortion just like when watching an IMAX movie, thanks to the inwardly curved screen.

For this reason, curved OLED TV, which allows the viewer to have the same experience of watching TV from the front even when watching it from the sides and maximizes immersion like watching a movie at a theater, is gaining attention in the market. Samsung and LG have already completed the development of 55-inch or larger curved OLED TVs and are planning to mass produce the products in full scale later this year if the reaction is positive.
III. Analysis of patent application trends

Curved Display – 2013
1. Technology classification for patent analysis

In this report, curved display technologies were classified into three: curved OLED, curved LCD, and others. The others are the patents regarding other display technologies, including projector or plasma display panel (PDP), than curved OLED and curved LCD technologies.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Classification of Technologies</th>
<th>Details</th>
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<tbody>
<tr>
<td>Curved Display</td>
<td>Curved OLED</td>
<td>OLED panel-using curved display technology</td>
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<tr>
<td></td>
<td>Curved LCD</td>
<td>LCD panel-using curved display technology</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>Curved display technologies other than OLED and LCD (e.g., Projector, PDP, etc.)</td>
</tr>
</tbody>
</table>

※ Research period: until 28 August 2013 (based on published date)
※ Research subjects: Published or issued patents in South Korea, the United States, Japan, and Europe, and under PCT
※ Research method: Used the keywords of the classified technology to extract related patents and then searched for patents by country
3. Patent application trends by year/country

The application of patents on curved display technology shows an overall increasing trend. Particularly in 2011, the number of application of such patents hit the record. By country, …
5. Patent application trends by assignee

By assignee, Hitachi Displays Ltd. (XX patents) applied for the greatest number of patents, followed by … Hitachi is found to have applied for a number of patents particularly on curved LCD technology.

* Others: 3 patents (KONICA MINOLTA HOLDINGS, MINOLTA, PANASONIC), 2 patents (…

Source: IHS

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6. Key patent selection and analysis method

Key patents are selected from the patents applied for in the United States and under PCT. After removing overlapped patents among them, 22 patents regarding curved OLED and 32 patents on curved LCD were selected as key patents.

This report is composed of key patent analysis on curved OLED, key patent analysis on curved LCD, and conclusion. It provides an in-depth analysis, containing status of key patents, technology development trends, and key patent abstracts.
IV. Key patent analysis – Curved OLED
1. Status of key patents

The bibliography of the 22 key patents on curved OLED technology is as follows.
- Eastman Kodak...

### List of key patents

<table>
<thead>
<tr>
<th>No.</th>
<th>Patent No.</th>
<th>Title</th>
<th>Application No. (Date)</th>
<th>Assignee</th>
<th>Forward citation</th>
<th>Backward citation</th>
<th>Patent family</th>
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<td>Semiconductor device and manufacturing method thereof</td>
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<td>Method for fabricating a semiconductor device by transferring a layer to a support with curvature</td>
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</tbody>
</table>
2. Technology development trends

Technology development map of curved OLED (2002-2005)

- **2002**
  - Eastman Kodak
  - US2004-XXXXXXX

- **2003**
  - Eastman Kodak

- **2004**
  - Eastman Kodak

- **2005**
  - Eastman Kodak

**Forming a substrate that includes the pixel area and the non-pixel area in a convex shape**

**Surface width of 48 cm to 200 cm (continuous curve, concave shape)**

**Patents transferred to**

Source: IHS  © 2013 IHS
3. Abstract of key patents

| Patent 1 |
|-----------------|-----------------|-----------------|
| **Publication No. (Date)** | **USXXXXXX (2007.XX.XX)** | **Legal status** | **Alive** |
| **Title** | **Application No. (Date)** | **US2002-XXXXX (2002.XX.XX)** |
| **Assignee** | **Technology Classification** | **Curved OLED** |

**Abstract**

**SAMPLE**

www.ihs.com

**Rep. claim**

1. ...

**Family members**

**JP2012XXXXXX**
V. Key patent analysis – Curved LCD
VI. Conclusion
1. Summary of patent application trends

The application of patents on curved display technology is on an upward trend, and it particularly peaked in 2007 and 2011. Patents on curved LCD technology accounts for more than 50%, while that on curved OLED technology and others make up 25% and 18%, respectively.

By assignee, Hitachi (XX patents) has applied for greatest number of patents, followed by …, The company seems to lead technology development in this field.
2. Patent competitiveness – Curved OLED

To see the patent competitiveness of each company, a citation analysis on 22 key US patents on curved OLED technology was conducted. The 22 patents cited XXX patents and are cited by XXX patents. In particular, the patents referred much to the technologies of … and have influenced the development of … technology.
3. Embodiment of key curved OLED patents

US2013XXXXXXX (#19), a patent from LG Electronics that is published in the United States, contains embodiments regarding the fabrication of curved OLED TV. The embodiment in Fig. 2 presents a method to make a display panel curved to correspond to the shape of back cover, which is in convex shape, by physically fixing the display panel to the fixed section of the back cover. …

Embodiment

- As shown in FIG. 2A, the display panel 11 may be …
VII. Appendix
List of curved display patents  (202 patents)

<table>
<thead>
<tr>
<th>No.</th>
<th>Patent / Publication No.</th>
<th>Title</th>
<th>Assignee</th>
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<td>Curved screen display</td>
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