Technology Intelligence
Flexible Display -2017
Overview

A Flexible Display is a display which is flexible in nature; differentiable from the more prevalent traditional flat screen used in the most electronic devices. It enables a new intuitive user interface, suitable for simple operations in application software and opens up new possibilities for flexible displays to be used as user-interface devices.

Applications

- Smart Card, Electronic Paper
- Mobile Communication
- Personal Computer/Portable Displays/E-Reader
- Large area Display
- Wearable Electronics
- Automotive Application
- Non-Display-Type Application (Toys, Plastic Art, etc.)
- Electronics Billboards

Display Technology

Based on either Reflectivity or Emissivity

Forms of Display:
- Flexible E-Paper based Display – Reflectivity
- Flexible OLED Based Display – Emissivity

Advantages

- Rugged
- Light Weight
- Portable
- Very Thin
- Ability to curve, flex, roll and fold
- Non-Brittle
- Low Power
- Limited Market Availability
- Damage by Water
- Portable
- Very Thin
- Ability to curve, flex, roll and fold

Disadvantages

- High cost manufacturing
- Limited Market Availability
- Damage by Water
- Portable
- Very Thin
- Ability to curve, flex, roll and fold

Differences

Reflective Based - E-Paper Technology
- Comfortable to Eyes, as reflect light like a real paper
- Relies on reflected ambient light
- Holds static image and text indefinitely without using electricity

Emissive based - Flexible OLED Technology
- Emits Light
- Each individual light generating pixel generate light when an electric charge is applied

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Trends and Market

Flexible Display Roadmap

1st Gen.  
Durable Display

2nd Gen.  
Bendable Display

3rd Gen.  
Flexible Display

4th Gen.  
Disposable Display

Challenges

- From traditional rigid substrates to flexible substrate
- Satisfy the requirements of both substrate and deposited electronics
- Handle the high processing temperatures encountered when making rigid displays
- Laminate adhesives that can perform reliably at high temperatures without being affected by stresses
- Achieving large quantity supply with comparative low cost

Market Size of Flexible Display


As we saw in 2009, the market size of the Flexible Display was small. But as the technology grows up the size of the market increases accordingly. In 2017, the market size for this technology grow up to 12,000 M USD and expected to be grow beyond this in consecutive years.
### Key Players

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<td>LG</td>
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<td>Apple</td>
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<td>Wohan China Star Optoelectronics Technology</td>
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<td>BOE Technology</td>
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Samsung has a large number of share for patent filing in 2017 i.e. 33% of the total patent filed for flexible display. After this LG has second number in patent filing share in 2017 i.e. 26% of the total Filing of patent.

#### Latest Inventions:

- **Samsung** filed a patent in 2017 in which:
  - A flexible substrate having a display region.
  - Non-display region located at an outer region of the display region.
  - An encapsulation member encapsulating the display region.
  - The thin film may have a plurality of thin films that include at least one of an organic thin film or an inorganic thin film
  - The non-display region may be folded to cover at least a side surface of the thin film.
  - The thin film may be formed by stacking a plurality of thin films that include at least one of an organic thin film or an inorganic thin film.

- **LG** filed a patent in 2017 in which:
  - Flexible display device includes the displaying area in which the organic light-emitting device and TFT (Thin Film Transistor) are equipped.
  - The flexible printed circuit board including the lower part non-display area.
  - Lower part non-display area includes bending area.

- **Apple** also filed patent in 2017, in which a electronic device having a opposing front and rear surface. Transparent member forms a rear surface of the device. A transparent cover layer is mounted to the housing member. Layer has a planer and curved portion. A Flexible display layer having an array of the display pixel.

- In another patent reference filed in 2017 by **Apple**, the display and multi-layer printed circuit may share a common layer formed from a flexible substrate. The flexible substrate may have portions that are integrated into the display and portions that are integrated into the multi-layer printed circuit board. An array of thin-film transistors may be used to control the emission of light from the display and may be formed on portions of the flexible substrate that are integrated into the display.
Xia Chuanjun is associated with a assignee Universal Display Corporation. In his latest publication of patent, novel heteroleptic iridium carbene complexes are provided.

- Selective substitution of the ligands provides for phosphorescent compounds that are suitable for use in a variety of OLED devices.
- The carbene complexes can also be used as materials in a hole blocking layer and/or an electron transport layer to improve device performance.

- The University Of Illinois
- The University Of California
- Arizona State University
- The University Of Michigan
- Nanjing Tech University

- In 2017, University of Illinois filed a patent for fabricating and assembling printable semiconductor elements which provides stretchable semiconductor structures and stretchable electronic devices capable of good performance in stretched configurations.

- University of California filed a patent which fabricate Micro LED diode using photoelectrochemical (PEC) etch. A sacrificial layer and III-V device layers are epitaxially grown on a host substrate, The sacrificial layer is removed by a photoelectrochemical (PEC) etch. The micro-EDs may be bonded to a sub mount with a polymer film deposited thereon.

HJ Laboratories in 2017 Filed a patent for mobile device with a flexible OLED Multitouch display with a pixel layer and an adaptive layer. The adaptive layer may include a resizable display area capable of being made semi-transparent by the controller.

Apple in 2017, filed a patent in the field of wearable flexible electronics. Device includes a flexible display, a flexible housing and one or more flexible internal components configured to allow the flexible electronic device to be deformed. Flexible displays may include flexible display layers, flexible touch-sensitive layers, and flexible display cover layers. The flexible internal components may include flexible batteries, flexible printed circuits or other flexible components.

Samsung filed a patent in which a display apparatus including a display panel, a polarizing member having an absorption axis and a transmission axis, and a first touch electrode extending in a first direction is disclosed.
In the computer application like monitor, laptop etc. large number of patent are filed i.e. 24% of the total number of patent filed in 2017. Also 13% of the patent are filed for mobile application like mobile screen. In the other application like automotive, toys, aerospace 50% of the patent are filed or published. There is also a innovation in the filed of wearable displays for which 6% of the patent are filed or published. In the filed of home appliance like television also a innovation and development is going on.

Majority of the patents are filed for the Flexible OLED display technology. Which shows a large innovation and development is done in flexible OLED Display Technology.

- In 2017, Chinese patent application CN107464895 is filed in which a carrier substrate is provided on which a flexible display device layer is fabricated to obtain a flexible display substrate and also a number of pixel is defined on the substrate.
- Display regions are formed by laser scanning.
- The display device layer defines a plurality of cutting lines.
- Each of the plurality of cutting lines encloses a plurality of flexible display screens.

In China Tongji University has filed a patent application in 2017 which provided a folding type mobile phone / computerized hyper-flexible device and relates to the technical field of ultra-flexible electronic devices. The device includes a front flexible foldable polymer encapsulation layer, a collapsible transparent film capacitive touch sensing layer, a collapsible polymer insulation layer, a foldable OLED display, flexible circuit board embedded with a rigid processor and battery, and a foldable flexible package bottom at the bottom.
**World’s first flexible, transparent 77 inch OLED Display**
The screen has a UHD resolution of 3840 x 2160, offers up to 40 percent transparency, and can be fixed with a curvature of up to 80 degrees. You can see what this all translates to in real terms with the picture above — it means you’ve got a massive, curved screen with a transparency similar to that of lightly tinted glass.

**BOE officially starts to produce flexible 5.5” smartphone OLED panels at its B7 fab in Chengdu**
The first panels produced by BOE are 5.5” in size with a resolution of 1440x2560 (QHD) - these are smartphone panels that will be adopted in an edge-type configuration. BOE says that its production line is highly automated, and BOE’s panels come with a touch layer already laminated. The whole panel is just 0.03 mm thick.

**Samsung brings the foldup phone a step closer with the world’s first ‘stretchable’ display**
Samsung has unveiled a radical 9.1-inch stretchable display. A flexible OLED (organic light-emitting diode) screen which could stretch in both direction by as much as 12 millimeters might spell out a new era in phone screen technology. Samsung says the stretchy screen will be useful for everything from wearables to in-car displays, and could also lead to a new generation of wearable devices that can be knocked or dropped and simply move back into place.
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Thank You!