2016 Display component market review and 2017 projection

2016.11.2 for IHS Technology Korea Display Conference

Irene Heo, Principal analyst
Polarizer

Two digit decrease in polarizer price
Polarizer makers continue to be in red
Demand of Non-TAC to be increased due to LCD TV enlargement
Imbalanced Supply/Demand of polarizer and sub-films
Concentration of polarizer manufacturing lines in China
Decrease in TV polarizer price has reached 20%

Source: IHS Report 'Display Optical film market tracker'
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LCD TV enlargement and Non-TAC polarizer

[Market share of PVA protection film usage]

Source: IHS Report 'Display Optical film market tracker'
IHS Report 'Large-area display market tracker'

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Correlation between TV size and the adoption of Non-TAC polarizer

Source: IHS Report 'Display Optical film market tracker'
IHS Report 'Large-area display market tracker'
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Concentration of polarizer manufacturing lines in China

<table>
<thead>
<tr>
<th>Maker</th>
<th>Location</th>
<th>Film width (mm)</th>
<th>Capacity (Km2/month)</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitto</td>
<td>Shenzhen</td>
<td>1,490</td>
<td>640</td>
<td>2018</td>
</tr>
<tr>
<td>Sumitomo</td>
<td>Wusi</td>
<td>1,490</td>
<td>1,400</td>
<td>Q3‘17</td>
</tr>
<tr>
<td>SDI</td>
<td>Wusi</td>
<td>2,260</td>
<td>1,700</td>
<td>Q4‘16</td>
</tr>
<tr>
<td>LGC</td>
<td>Nanjing</td>
<td>2,260</td>
<td>2,700</td>
<td>Q1‘16</td>
</tr>
<tr>
<td>CMMT</td>
<td>Kunshan</td>
<td>1,490</td>
<td>720</td>
<td>Q2‘17</td>
</tr>
<tr>
<td></td>
<td>Kunshan</td>
<td>2,260</td>
<td>1,200</td>
<td>1Q‘18</td>
</tr>
<tr>
<td>Sunnypol</td>
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<td>1,490</td>
<td>900</td>
<td>Q2‘17</td>
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Source: IHS Report ‘Display Optical film market tracker’
Imbalanced Supply/Demand of polarizer-by region

Source: IHS Report 'Display Optical film market tracker'

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Imbalanced Supply/Demand of polarizer-by UV lines

Source: IHS Report 'Display Optical film market tracker'
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Display Driver IC

Cost reduction - TRD, DRD, GOA
High resolution – Heat problem from DDIC
Changes in bonding technology
System on Film
Driver IC market forecast

- DRD and TRD will have a negative impact on the driver IC demand forecast, even though 4K products will grow.
- Gate driver IC is expected to fall due to the increase in share of GOA.
- Almost small/medium panels use a single chip for driving.

Source: IHS Report 'Display Driver IC market tracker'

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GOA double rate/tri rate driving structure

- **DRD:** One s-channel accepts two signal of g-channel. \((S-ICs \rightarrow 1/2)\)
- **TRD:** One s-channel gets to control three sub pixels at the same time. \((S-ICs \rightarrow 1/3)\)
- **GOA** is necessary for DRD or TRD due to DRD/TRD asks large number of Gate ICs.

[Diagram showing DRD and TRD structures]

Source: IHS Report ‘Display Driver IC market tracker’
Cost reduction of DDIC

- DRD + GOA and TRD + GOA are good ways to reduce costs. Panel makers are aggressively applying DRD + GOA and TRD + GOA for 2016 TV models.
- Chinese VA panel makers have an interest on TRD, so they are focusing on Samsung’s TRD products.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Source pin</th>
<th>Conventional</th>
<th>GOA</th>
<th>GOA+DRD</th>
<th>GOA_TRD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD 1366 x 768</td>
<td>720</td>
<td>6 + 2 = 8</td>
<td>6 + 0 = 6</td>
<td>4 + 0 = 4</td>
<td>2 + 0 = 2</td>
</tr>
<tr>
<td></td>
<td>1440</td>
<td>3 + 2 = 5</td>
<td>3 + 0 = 3</td>
<td>2 + 0 = 2</td>
<td>1 + 0 = 1</td>
</tr>
<tr>
<td>FHD 1920 x 1080</td>
<td>960</td>
<td>6 + 2 = 8</td>
<td>6 + 0 = 6</td>
<td>4 + 0 = 4</td>
<td>2 + 0 = 2</td>
</tr>
<tr>
<td>4K 3840 X 2160</td>
<td>960</td>
<td>12 + 4 = 16</td>
<td>12 + 0 = 12</td>
<td>8 + 0 = 8</td>
<td>4 + 0 = 4</td>
</tr>
<tr>
<td>8K 7680 X 4320</td>
<td>960</td>
<td>24 + 8 = 32</td>
<td>24 + 0 = 24</td>
<td>16 + 0 = 16</td>
<td>8 + 0 = 8</td>
</tr>
</tbody>
</table>

The driver IC interfaces are based on faster standards such as USI-T and EPI.

Source: IHS
4K Driver IC trends

- Demand for 4K panels will increase across many applications. Demand for driver ICs will increase accordingly.
- 4K TV demand is growing rapidly and will become a major panel application in 2017.
- Panel makers want to reduce the number of driver ICs necessary for a 4K panel. And it can cause the heat problem from driver IC. Solving the heat problem may be critical success factors.

Source: IHS Report ‘Display long-term demand forecast tracker’
Driver IC for LTPS Notebook PC

• Driver IC for LTPS Notebook PC is as same as Smartphone Driver IC. Usually LTPS Driver IC one source channel supports RGB 3 colors. Some makers are trying 6 split driving for LTPS Driver IC.

• a-Si 4K NotePC panel needs 960 channels 12 source Driver IC. 6 split driving of LTPS requires only 2 chips. (12*0.8 = 9.6$ vs. 2*1.8 = 3.6$)

Source: IHS Report ‘Display Driver IC market tracker’
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Issues concerning heat problem from DDIC

- CPU → Timing controller → Driver IC

<table>
<thead>
<tr>
<th>Proposed solution</th>
<th>Part</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Driver IC package</strong></td>
<td>Special resin</td>
<td>• Special resin to absorb the heat is applied to the part of Driver IC after mounting DDIC on COF</td>
</tr>
<tr>
<td><strong>COF</strong></td>
<td>Structural modification</td>
<td>• To raise the thickness of Cu layer of COF can give DDIC package some space to emit the heat from Driver IC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Adoption of long COF can help to emit the heat from Driver IC through its long body.</td>
</tr>
<tr>
<td></td>
<td>Ultra low temperature COF</td>
<td>• Add layers like Al and Cu which has the heat sink function onto COF</td>
</tr>
<tr>
<td><strong>The heat sink film</strong></td>
<td></td>
<td>• Very simple and effective, but expensive solution, some very large and expensive products for special usage like PID are adopting graphite sheet as role of the heat sink</td>
</tr>
</tbody>
</table>

Source: IHS
Touch embedded driver IC and TDDI

- Synaptics, FocalTech, and Novatek are TDDI chip vendors.
- Synaptics was the only supplier until Q2’16, “One package two chips” has been generally used.
- As of Q3’16, Single chip solution was introduced, and panel makers started to apply it aggressively.
- Accordingly, IHS has increased TDDI forecast as compared to Q2’16.

Source: IHS Report 'Display Driver IC market tracker'

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Changes in bonding solution - Mobile phone

### Bonding technology of panel and DDIC

<table>
<thead>
<tr>
<th></th>
<th>COG</th>
<th>COF /COP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Merit</strong></td>
<td>• Able to connect DDIC to the panel glass without extra linking components</td>
<td>• Chips and modules can be miniaturized</td>
</tr>
<tr>
<td></td>
<td>• Super slim light</td>
<td>• Able to folded and bended by the film’s flexibility</td>
</tr>
<tr>
<td><strong>Demerit</strong></td>
<td>Requires sufficient space to place DDIC</td>
<td>• Increase in cost due to extra film</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limitation on resolution</td>
</tr>
</tbody>
</table>

Source: IHS

[ Side view and bezel type by bonding technology ]

Conventional bezel  
Slim bezel  
Like bezel-less
Changes in bonding solution - TV
Flexible OLED components trend

Polarizer
Touch sensor
Three types of On-cell for flexible touch

- Current development trends are based on the on-cell for flexible type, but they can be further categorized into three types by manufacturing process.
Process comparison between “Y-OCTA” and “Integration with barrier film”

**Y-OCTA**

- Flexible OLED
- Overcoat
- Metal sputter for touch sensor
- Low temperature sensor patterning

**Integration with barrier film, Transfer method**

- Carrier film
- Metal sputter for touch sensor
- Sensor patterning
- Transfer sensor pattern to barrier film
- Lamination barrier film on to TFE layer

**Integration with barrier film, TCTF solution**

- ITO sputter on barrier film
- ITO patterning
- Transfer AgNW layer
- Hitach TCTF** film
- AgNW patterning
For ideal flexible OLED solution

- Reducing the number of substrates used in OLED module is one of the most important factor for flexible display
Thank you for your attentions

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