Challenges of the Flat Panel Display Industry

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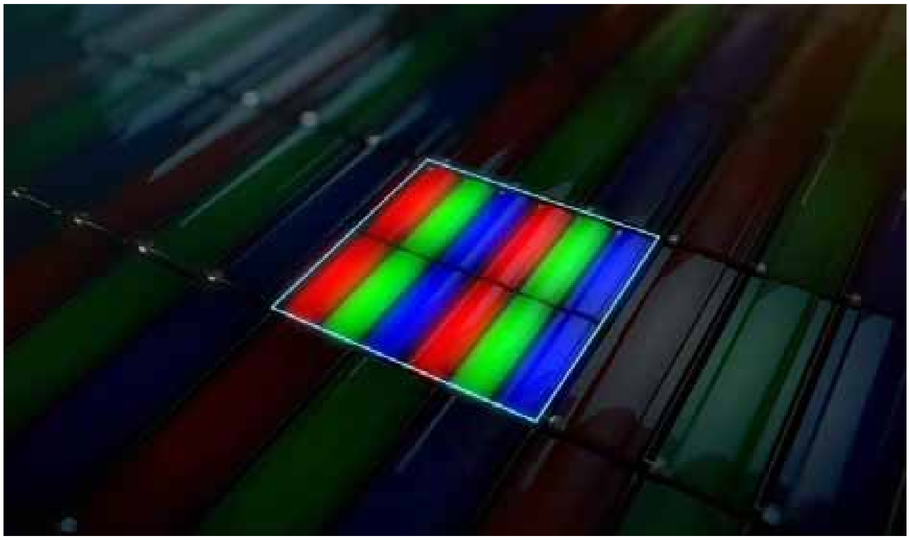

Photo Courtesy: Apple's New iPad Keynote

It is very common and widely accepted to use Flat Panel Displays (FPDs) as display devices for computers, cell phones, tablet PCs, and TVs etc. The most popular FPD device is Thin Film Transistor Liquid Crystal Display (TFT LCD). Organic Light Emitting Diode (OLED) displays are also used for mobile devices and will be for the next generation. Unlike the semiconductor device industry, the FPD industry is strongly led by Asian countries since it was initially developed and commercially used in Asia. Under this market leadership, two major things happened in the Asian FPD manufacturing companies. First, the base glass plate size has increased extremely fast due to a cost effective approach by manufacturers to compete with other players in the FPD industry. There is Generation 1 up to G8 for bare glass plate sizes. For example, bare glass plate size is 730x920mm for G4 and it is 2200x2500mm for G8. This means that production efficiency is increasing and manufacturers will get eighteen 32-inch panels or eight 42-inch panels from G8 glass plate throughout the processes. In addition, glass plate thickness went from 0.7mm down to 0.5mm due to display devices competing for total thickness. The second thing becoming very challenging to most manufacturing companies is to make higher definition display devices from 1Mega pixels up to 4Mega pixels for full HD and 8Mega pixels for ultra high definition display, UD. One more thing! FPD devices get fast refresh rates, from 60Hz up to 120Hz and 240Hz. This means more data lines or gate lines on panels depending on their technology and a more narrow technology node applied to it. As a result, they must have better capability for manufacturing more sensitive devices in facilities. All these technical challenges are still happening silently and unexposed to the public in this fast growing market, which is a highly competition and price driven industry.

Changes and transitions are directly or indirectly correlated with static related problems in the FPD industry and its increasing demands. As described earlier, these changes increase device sensitivities to ESD and more sensitive particle contaminations. In fact, over past years, there were just a few occurrences of ESD damage and people used basic static control countermeasures even if this solution did or did not improve yield. Starting with early generations of TFT LCD fabrication processes, static control countermeasures were deployed, but most engineers had no evidence that these solutions worked and were just used as insurance without any technical research or feedback. Untrained technicians and vendors drove these results for marketing reasons. For example, manufacturers report having over 7,000 clean dry air gas ionizing bars, but it doesn't directly correlate with yield improvement or explain how they solved their problems. In addition, they applied conductive polymers on conveyor rollers or lift pins, and fluorine coating on their glass plate stages to reduce their problems which provided very small improvements and was not a permanent solution for the TFT LCD manufacturing processes. These manufacturers simply benchmarked and used general ESD countermeasures from semiconductor assembly or surface mount technology manufacturing processes in their facilities.

In fact, over 90% of FPD static related problems are micro particle contamination and more ESD problems are becoming an issue. This is exactly the same as in semiconductor

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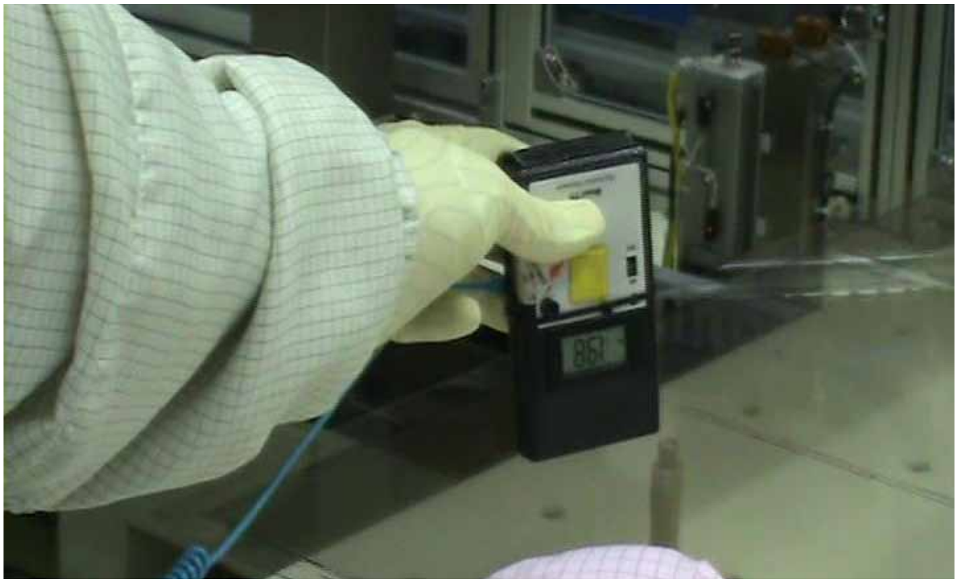
fabrications, when glass technology becomes narrower, killer particles get smaller which is strongly related to static fields inside the processes. This leads to ESD issues that are more serious and growing problems in FPD manufacturing processes as device sensitivities increase.

What are some causes? First, the FPD industries bigger glass plates change the physical rules of FPD fabrication processes and static related issues. For example, glass plate transfer systems expose the glass to more contamination because it is not successfully enclosed during operation and transportation. Some solutions are benchmarked from the semiconductor industry, but not all.

Second, The FPD industry engineers are currently studying the problem and how it relates to their problems as most of the technology is based on insulators not semiconductors or conductors. Most of the equations and formulas currently studied are based on conductor and semiconductor device failure models. The manufacturing processes of FPD are very similar but this does not mean semiconductor assembly countermeasures will work in FPD plants.

At this time, there are no FPD device stress testing methodologies. Some companies are using TLP testing on TFT LCD panels which is representative for HBM, not a bare hand is touching the panel at any time which is when semiconductor device failures often occur. ESD events on glass panel differ due to surface resistance, air gap, and layer thickness on the panel. Semiconductor device testing methods were designed around total transferred energy calculated models, but FPDs can't do this the same way as more sensitive electrostatic field devices. It is the same voltage, but a different discharge mechanism happens.



Typical Static Charge on FPD Glass Plate

The ESDA has recognized the problems of this troubled industry and is working to provide accurate understanding, training, and proper testing methods for flat panels. The Advanced Topics Team of the ESDA is starting to look at these topics and working on the possibility of organizing a FPD panel testing standard working group. Publishing standard testing documents for FPD panel is an encouraging agenda. If we all work together, ESDA members, volunteers, and engineers we can make some groundbreaking steps forward!

Typical FPD Transfer Area