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TECHNICAL NOTE

Electrostatic Damage in TFT & CF Flat Panel Display Manufacturing

The Science of Charge Generation

Static electricity is caused by the contact of two dissimilar materials that are then separated. Dissimilar materials can include isolators and conductors. A small fraction of the electrons bound to one of the materials gets transferred to the other material. In a cleanroom, 10,000 volts or more may easily be created by this process. This process is called triboelectric charging. The low humidity, ultra-clean environment of a cleanroom together with the use of insulators such as glass substrates and Teflon means that charge does not have a way to dissipate. Instead, it remains on objects in the fab indefinitely.

Charge Generation in FPD Manufacturing

Contact and separation occurs frequently in flat panel display (FPD) manufacturing. Substrates are handled by robotic arms and then moved off the arm. Substrates may be covered with water or other chemicals and then driven off by spinning, which is a particularly powerful charge generator. Static charge generation can drive sparks across sections of the plate and cause physical damage to the TFT circuitry or to the color filters. This results in millions of dollars worth of scrapped product each year.

A common process in FPD manufacturing is the movement of substrates over plastic rollers. The movement leaves charge on the back surface of the substrate as it moves through the process tool. Often Teflon, which is a very efficient tribocharger, is used as the roller material. Backside charge on the bottom of a panel is as destructive as the charge on the top. This issue has not been widely addressed in FPD fabs, although the damage it causes is serious and costly.

Backside Charge

Glass is an insulator that does not act as an electrostatic shield, as metal plates do. Electric fields generated by backside charge penetrate glass, which can drive sparks that damage TFT (thin film transistors) and CF (color filter) structures on the top of the glass.

In a flat panel fab, ionizers are often doubled or tripled up over a process in tool locations where there have been significant amounts of damage observed. To fight backside charge, this concentration of ionizers is situated at the end of a long line of Teflon rollers because ionizers above the plate do not solve the problem of backside charge.

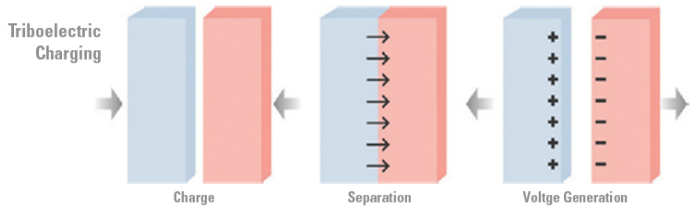


Figure 1. Triboelectric Charging

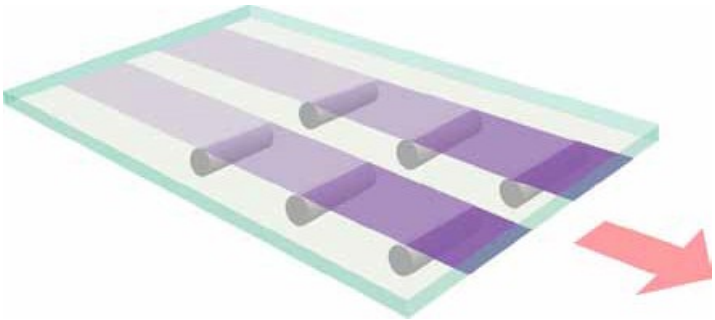
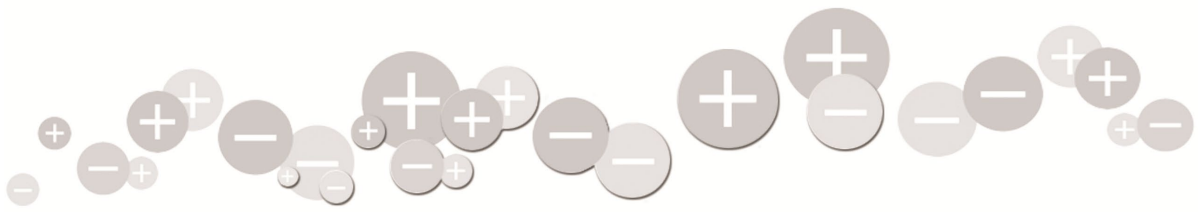


Figure 2. Teflon Rollers Charge The Bottom Of The Substrate



Ionization Solutions for Backside Charge

To effectively manage the problems resulting from backside charge, the following actions should be taken:

- Install ionizers below the plate on the production line.
- Choose a strategic location where the bottom side charge is problematic.
- Choose the correct type of ionizer for the application, ensuring that the ionizer can fit under the path of the glass and is capable of operating close to the panel and without ambient airflow.

One solution is alpha ionization. An alpha ionizer comprises small amounts of Polonium 210 (Po210) as the active element. The alphas travel up to 3.8 cm in the air, producing large amounts of ionization in their path. When the electric field generated by static charge on plates is taken into account, the range of ionization from an alpha bar is effective in charge dissipation up to approximately 10 cm. Since the thickness of the alpha bar structure is less than 2 cm, it will easily fit under the substrates as they move along the rollers. The bar should be placed so the ionization lines up with the rollers.

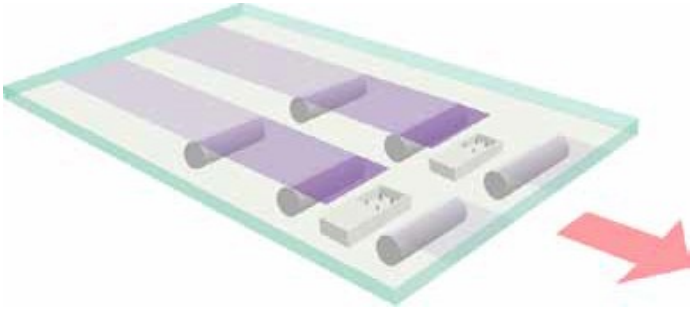


Figure 3. Teflon Rollers Charge The Bottom Of The Substrate

Another solution to backside charge problems is the QuadBar. This tiny, self-contained bar is only 3.2 cm tall and utilizes corona discharge as the source of ionization. The patented quadrapole point configuration of the QuadBar means that electric fields from the unit are effectively canceled, allowing placement as close as 20 mm from the object to discharge. Its emitter points produce an "ion wind" within 4 cm of the bar, thus propelling the ions toward the substrate. By placing several QuadBars across the width of a plate and aligning them with the locations of the contact between the plate and the rollers, the QuadBar's design for tight locations makes it an excellent solution to the underside discharge requirement for the FPD industry.

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