

## Rubbing of polyimide

An LCD requires that the liquid-crystal molecules at the two glass surfaces of the cell can be aligned in parallel to the two polarizer foils. This is achieved by coating the inner-surfaces of the cell with a thin, transparent film of polyimide, comprising long chain-like molecules. When this film is rubbed by a velvet cloth, microscopic grooves are generated in the polyimide layer and the liquid crystal molecule in contact with the polyimide surface align in the rubbing direction.

The result is a twisted or helical structure of the liquid crystal molecules which try to align parallel to each other. The tilt of the molecules is larger in the mid layer of the display due to the restoring forces of the molecules anchored on top of the orientation layer. A proper orientation of the liquid crystal molecules versus the orientation layer results in low addressing voltage of the pixels in the display, while disorientation of single crystals molecules requires an increased electrical field.

Therefore, rubbing is an important process step in LCD manufacturing. The proper anchoring of the liquid crystals in the orientation layer depends upon:

- Printing technology of the polyimide layer. Normally flexo-printing technology is used. Printing direction, antiparallel to the rubbing direction increases the orientation effect of the liquid crystals.
- Well defined and homogeneous rubbing of the layer by a velvet rubbing cloth.

Rubbing machines use automatic or manual loading and unloading of the glass plates. The glass is held by vacuum on the operation table. A large, rubbing role, covered by a special velvet cloth, is passed over the orientation layer with a well defined speed, pressure and angle.

Flatness of the rubbing table, consisting of fine ceramic is very important. The rubbing process can generate particles. Therefore a proper air-flow management, using HEPA filters is required. Glass plates are thereafter cleaned using an ultrasonic air-knife. Electrical charging of the glass plates is measured and discharging carried out by an ionizer. A special mechanism eases the dismantling and the installation of the rubbing roles and the covering with the rubbing cloth.