

Innovative Applications in FPD Manufacture using High Power Q-Switch DPSS Lasers

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Abstract An overview is presented of state of the art FPD manufacturing techniques using high power nanosecond pulsed IR lasers to directly pattern thin films on glass. This includes an innovative method for patterning Black Matrix on glass for LCD manufacture, as well as patterning ITO on glass for PDP manufacture.

1. Introduction

In the manufacture of Flat Panel Displays (FPDs) a significant cost is the use of wet-etch lithography. Given the price pressure on all FPDs in the global market, alternative more cost effective techniques are being sought. One such technique is the use of lasers to directly pattern thin-films, usually Transparent Conducting Oxides (TCOs), on glass. This has been investigated for over fifteen years using various laser technologies of varying pulse durations and wavelengths [1- 2]; however it is only in recent years that a credible industrial laser technique has been developed to compete with wet-etch lithography [3]. This process has achieved significant industrial uptake in the volume manufacture of Plasma Display Panels (PDPs) for patterning Indium Tin Oxide (ITO) on glass [4].

A new technique for FPD manufacture using lasers is to pattern the Black Matrix (BM) resin that acts as a contrast enhancer for the Colour Filters in a TFT-LCD display. The current patterning method is wet-etch lithography, and there is pressure to move away from this technique to a more cost effective one. In this paper the authors give an overview of an innovative new laser process called Assist LiquidTM which enables the rapid laser patterning of BM to the demanding tolerances required for HDD-LCD manufacture.

2. Rapid Laser Patterning of ITO for PDP Manufacture

A high average power Q-switch diode-pumped solid-state Nd: YAG laser at 1064nm wavelength is used for this process. In a technique similar to that used for Excimer laser processing; the laser beam is passed through a homogeniser, which creates a uniform rectangular energy profile. This energy profile illuminates a transmission mask. The mask plane is then demagnified and reimaged to create an image plane upon the workpiece, using a galvanometric scanner with an f-theta flat field lens. Each pulse has sufficient energy to selectively remove the absorbing ITO layer without affecting the transparent glass substrate beneath. The ITO layer is typically 100-200nm thick. By using the scanner to steer the beam at high speed it is possible to separate the pulses at kilohertz

rep rates and by overlapping adjacent pulses rapidly pattern the ITO to create a complex transparent electrode structure.

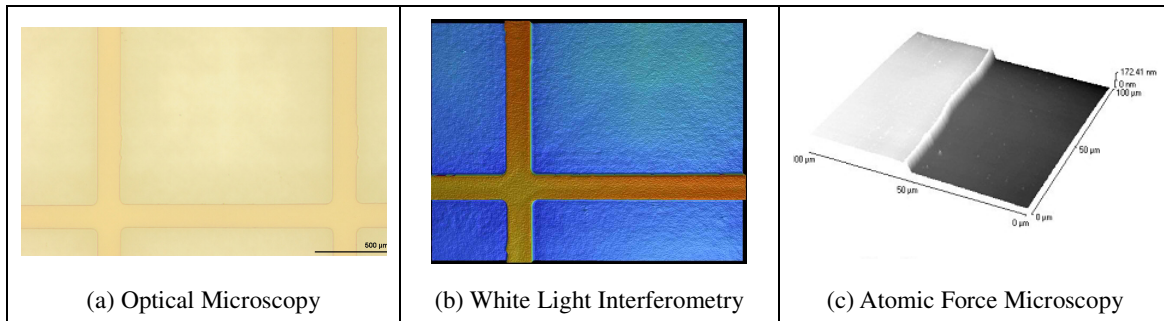


Fig 1: ITO on glass patterned by RLP – analysed using different techniques

The figure above shows three techniques employed to analyse RLP of ITO. It is found that the ITO is removed with a quality equivalent to or greater than that of wet-etch lithography. By employing multiple lasers upon a single patterning system it is possible to pattern a full Gen 8 mother-panel at competitive process rates. The improvements in yield offered by RLP, plus a lack of chemical costs, can result in very significant savings. This is per production line, for a cost depreciation of greater than one year, when compared with wet-etch.

3. Black Matrix Patterning for LCD using Assist Liquid™

An extension of this technique is to pattern BM for LCD manufacture. The tolerances required are very demanding and the conventional RLP process is unable to meet them. However an innovative process has been devised to solve this - called Assist Liquid™. The technique requires the laser beam to be imaged through the glass on to the interface between the BM and glass. The BM film is simultaneously sprayed with a water jet. This results in improved edge resolution and straightness, over conventional RLP, and an elimination of residue. Edge resolutions (width) of $<1\mu\text{m}$, with an edge straightness $<0.3\mu\text{m}$ (Standard Deviation), and negligible transmission loss are achieved consistently for this patent pending process. The process is also up to x3 more energy efficient than conventional RLP.

4. References

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