Ablation of Thermally Conducting Oxides

Material
ITO film on glass

Use of ITO Film on Glass in TV Screens

Introduction
Transparent Conductive Oxides (TCO) are a group of thin films widely used for liquid crystal displays, flat panel displays, plasma displays, touch panels, electronic ink applications, organic light-emitting diodes, antistatic coatings, and EMI shielding in solar cells. Their function is the same in most cases, to allow light transmission and electrical conductivity. Indium Tin Oxide (ITO) is the most widely used of these TCO films. It is transparent and colorless in thin layers. It has an excellent combination of electrical conductivity and optical transparency.

ITO films behave as metals to long wavelength light because of the presence of a plasma wavelength above 1 μm. At longer wavelengths, IR reflectance is related to the sheet resistance of the film; sheet resistance must be <30 Ωcm to obtain IR reflectance >80%

Laser processing v/s chemical etching of TCO films

Chemical etching is widely used for the localized removal of these films but is clearly not an environmentally friendly processes and so non-chemical process are being actively sought. In the European Union rules are now in place to ensure that for any industrial process, if a choice is available, the more eco-friendly choice must be made.

Industrial lasers, and in particular fiber lasers are now finding widespread use for the removal of these films using a selective ablation process at relatively high power densities. Fibers laser, in common with more complex Q-switched lasers, utilize a high intensity ablative process to vaporize the ITO directly from the surface substrate to produce the required patterning. Results have shown that most ITO films absorb well in the deep UV and in the near IR wavelengths but not at 355 or 532 nm so IR laser is a natural choice for this application. Traditional wet chemistry processes are multi-stage processes while the laser offers a simple single stage process option.

The cost associated with process development is significantly reduced due to full software control of the laser ablation process.

Advantages of pulsed fiber lasers:

20W Pulsed SPI MOPA Laser

Excimer, femto second and pico second lasers have been evaluated for this application but lack the power levels required at a realistic cost. 20W SPI's DM MOPA pulsed fiber lasers are very cost competitive in the order of 1000 $/W.

Higher average power Q-switched lasers used for this application usually require a mask for this process and high average power is necessary to ablate a single pixel with a single laser pulse. Complex optics including a precision orthogonal lens array is required. A lower power lower pulse energy process such as performed by the fiber laser can achieve similar results but with a simpler optical arrangement. The fluences required, in the order of 3 J/cm^2 are comfortably achieved using readily available widely used off-the-shelf optics. Complete software control of a direct ablation process simply requires a short term process development with no additional equipment costs.

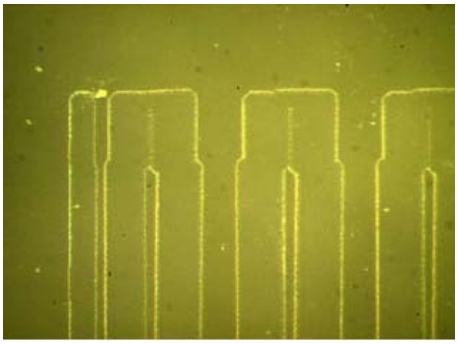
SPI's nano-second pulsed fiber lasers have a unique combination of laser parameters that distinguishes them not only from diode pumped solid state (dpss) lasers but also from q-switched fiber lasers that have been used for this application. SPI's 20W pulsed fiber laser gives higher peak power, up to 14 kW, with pulse energy of up to 0.8mJ, which is appropriate for

this process.

Set-up:

Laser: 20W directly modulated MOPA
Scan head: Hurryscan 14
Focal length: 163 mm, x2 beam expansion
Laser Parameters: 25-500kHz WF0-5 depending on coating
Scan speed: up to 1 m/s

Results:



This pattern was derived to permit a clear photograph

Line widths down to 30µm can be achieved with the fiber laser. Patterning accuracy needs to be around 5 µm, this is readily achieved using state of the art galvanometer scanners.
PDP's feature size is typically in the order of 1mm x 1mm with a resolution of 10 µm. For large area coverage, a 'step and repeat' process may be utilized and in some instances, multi-laser installations may be required to increase throughput.

The benefits of fiber delivery which is clearly an intrinsic part of any fiber laser system are easy to understand for machine integrators.

Process Advantages of Fiber Lasers
The advantages of such a system are as follows:
• The laser gives fiber delivery via a small BDO (beam delivery optic) that can readily be configured to give appropriate beam diameters into the focusing optics of the head.
• SPI's PulseTune waveforms allow greater parametric control and optimisation of the processing parameters.
• Low maintenance requirements and high system uptimes particularly in 24/7 operations.
• Fiber delivery allows the laser to be totally isolated from vibration and particulate contamination
• The lack of optical parts ensures no alignment drift with time or due to vibration.

Conclusions:
Directly modulated pulsed fiber lasers can be used very cost-effectively to remove ITO coatings.
Ablation quality has been shown to be excellent with complete removal of the layer and no damage to the underlying glass substrate.
Processing speeds are typically in the order of 1m/s but vary significantly depending on TCO composition, morphology and thickness.

For further information & to register for your FREE 30-day SPI Fiber laser evaluation unit, please contact the following BFi OPTiLAS offices:

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