Application Focus

Industrial Laser Applications Lab

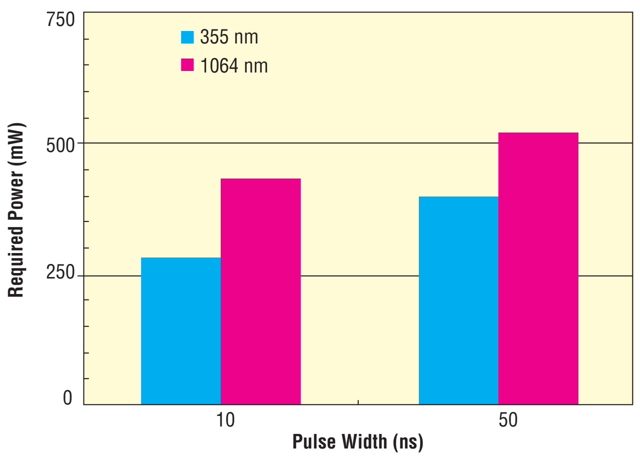
No. 11

Laser Patterning of ITO for Flat Panel Displays

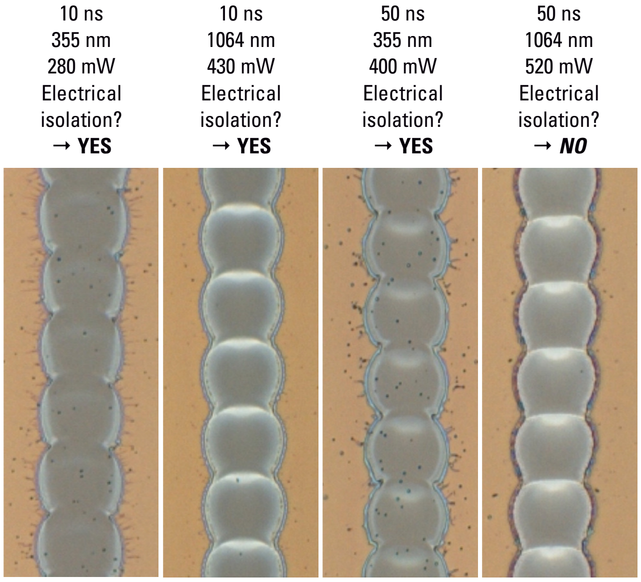
Laser patterned ITO-coated glass is a key enabler for flat panel and touch panel display devices. This market grew significantly with the adoption of flat panel displays for portable devices such as smartphones, video games, tablet PCs, and GPS systems, and is expected to grow further with the coming adoption of touch screen displays for laptops and PCs.

Since the laser is the tool of choice for patterning thin conducting films such as ITO; and since the process is a high-volume, 24/7 operation, it is important to choose the right laser to ensure a cost-effective, high-quality manufacturing solution.

We have studied the performance of short and long pulse, infrared (IR) and UV Q-switched diode-pumped solid state (DPSS) lasers for removal of ITO film from glass. The laser output was irradiated directly on the ITO film. Using wavelengths of 1064 nm and 355 nm and pulse durations of ~50 ns and ~10 ns, the efficiency and quality of removal for ~120-nm thick ITO was characterized.



For creating a 20-µm wide scribe in 120-nm thick ITO film on glass, a shorter wavelength and shorter pulse width offer a clear advantage in process efficiency.



Microscope photos demonstrate quality advantage with shorter pulses. IR scribes have less splatter, but there is also incomplete ablation (white residue within scribe).

The results of our study demonstrate the clear advantage of a short-wavelength, short-pulse duration pulsed laser process. In terms of processing efficiency, 10 ns, 355 nm pulses were found to be superior, requiring about half the power compared to 50 ns, 1064 nm pulses, and 30% less power than the 355 nm long-pulse counterpart. This higher efficiency can translate into a faster process or a lower power laser for the same job and less undesirable excess heating of the sample.

It is also noteworthy that long pulse 1064 nm scribes are not electrically isolating, whereas all other scribes—including those with the 10 ns IR pulses—were found to be isolating to >30 MOhm. This lack of electrical isolation may be due to a conductive residue formed in the scribe.

Since short pulse width 1064 nm pulses generated good scribes, it is possible that some ITO scribing applications could use the more robust and cost effective 1064 nm wavelength laser. However, for the smallest and finest scribe features, a 355 nm wavelength laser is a better choice.

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Laser Patterning of ITO for Flat Panel Displays

Although the microscope photos seem to show more processing debris surrounding the scribes when using 355 nm vs. 1064 nm (particularly for the longer pulse), the photos also indicate that within the scribe itself, the UV light more completely removes the ITO with less excess heat delivered to the material. With IR irradiation, conductive residual material is seen to remain within the scribed region (visible as light/white haze in the microscope photos). This residue is strongest with long pulse 1064 nm scribe, and gets successively weaker with both decreasing wavelength and decreasing pulse duration. The more heat delivered to the material during IR laser scribing which forms larger heat affected zone is believed to be the reason for higher residual material left behind in the scribe region. Hence use of a UV 355 nm laser is preferred for scribing ITO film.

A further advantage of using the 355 nm wavelength is that finer features are easier to process. The ability to focus the beam more tightly and with a larger depth of focus translates to a more robust process for the finest of features and on the widest variety of materials, including those with less than perfect flatness specifications.

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Model	Wavelength	Peak Power	Average Power	Pulse Width	Repetition Rate
Pulseo 355-10	355 nm	~5 kW	>10 W	<23 ns at 90 kHz	0–300 kHz
Pulseo 355-20	355 nm	~10 kW	>20 W	<23 ns at 100 kHz	0–300 kHz
Tristar 355-3	355 nm	0.9 kW	>3 W at 50 kHz >2 W at 90 kHz	<25 ns	1 Hz – 300 kHz
Explorer 355-300	355 nm	>0.6 kW	>300 mW at 50 kHz	<10 ns at 50 kHz	20–150 kHz

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