Atlantic
SERIES

INDUSTRIAL Picosecond Diode Pumped Laser

Laser micromachining is rapidly becoming the material processing technology of choice for numerous small scale, real world applications. New advances in diode pumped solid-state (DPSS) lasers are enabling material processes once found only in research laboratories to be incorporated into growing numbers of production lines

From its inception, the Atlantic – a new generation picosecond high power and high pulse energy laser – has been designed as a versatile tool for a variety of industrial material processing applications.

The Atlantic is an OEM rugged, compact laser with 16 W output power at 1064 nm. It features high pulse energy (up to 160 μJ), good beam quality (M^2 < 1.5) and a very high repetition rate (up to 500 kHz) of typically 10 ps pulses. Optional harmonics are available at 532 nm and 355 nm.

Optical components are installed in a robust, precisely machined monolithic aluminum block, which could be used as a separate module for customized solutions. The system is sealed to provide long term stable operation in manufacturing environments. Designed for hands-free operation, the Atlantic offers maximum reliability due to an optimized layout, PC-controlled operation, a built-in self-diagnostics system and advanced status reporting. Superior beam quality allows easy focusing of the laser beam into the smallest spot size at various working distances and enables processing of practically any material.

The Atlantic has been designed as a low-maintenance-costs solution. All replacement of consumables can be performed at user facilities by trained technicians.

FEATURES

- Up to **~160 μJ** pulse energy
- Up to **500 kHz** repetition rate
- Short pulse duration **~10 ps**
- Excellent beam quality **M^2<1.5**
- **16 W** output power at 1064 nm
- Reliable hands-free operation
- Compact, sealed and rugged design
- PC control and remote control keypad
- Low maintenance costs
- Single-phase powering
- No external cooling water

APPLICATIONS

- Drilling
- Cutting
- Paterning
- Structuring
- Ablation
- Micromachining
- Your applications welcome...

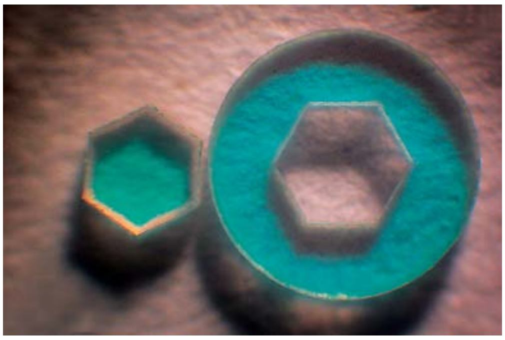
ADVANTAGES OF PICOSECOND LASERS

Impressive progress has been made in picosecond laser technology, making these lasers a reliable tool for a host of industrial micromachining applications that were impossible a few years ago. The picosecond pulse duration is comparable with the time of electron-phonon relaxation and is short enough for "cold" ablation.

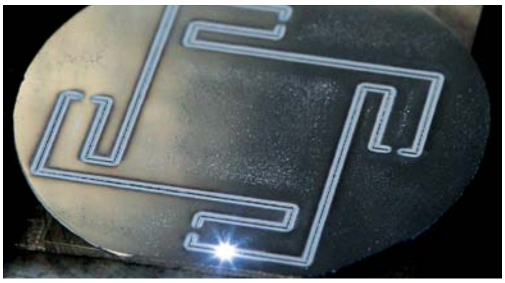
The Atlantic also offers a UV wavelength option that lowers the ablation threshold of many materials. This means a lower pulse energy, which further reduces the thermal stress of the workpiece. Picosend lasers also have a number of advantages over the shorter-pulsed femtosecond lasers. With no need to stretch and compress pulses for amplification, picosecond lasers have a less complicated design and are therefore more cost-effective and reliable. At the same time, picosecond pulses remain sufficiently short for very precise and stress-free micromachining. Picosecond lasers are capable of processing a wide range of micron scale features in almost all materials, including:

- Metals
- Semiconductors
- Diamond
- Sapphire
- Ceramics
- Polymers
- Composites and resins
- Photoresists
- Thin films
- ITO films
- Glass

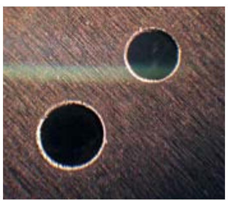
MICROMACHINING SAMPLES



The round and hexagonal parts cut out from the LCD filter glass with thickness of 0.3 mm using the Atlantic series laser radiation at 266 nm

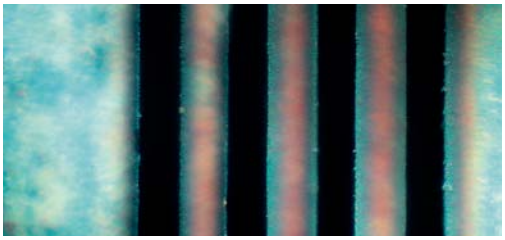


Silicon cutting

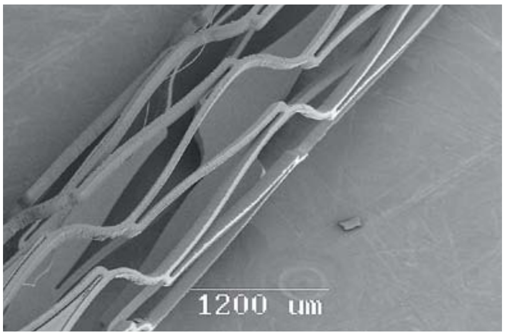


Holes cut by laser in tantalum (0.4 and 0.3 mm diameters)

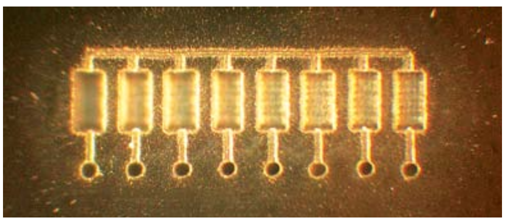
Holes cut by laser in tungsten (0.5 and 0.3 mm diameters)



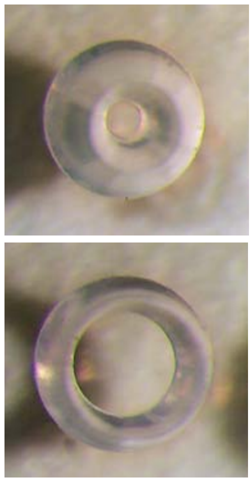
Slots cut in the Invar mask for OLED & LCD with the Atlantic series laser: 266 nm, 100 kHz, 0.35 W; thickness 34 μm; cutting speed 5 mm/s



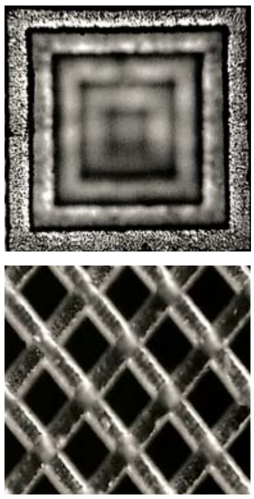
Stents cut from the Nitinol,
Courtesy of CORTRONIK GmbH & Co. KG



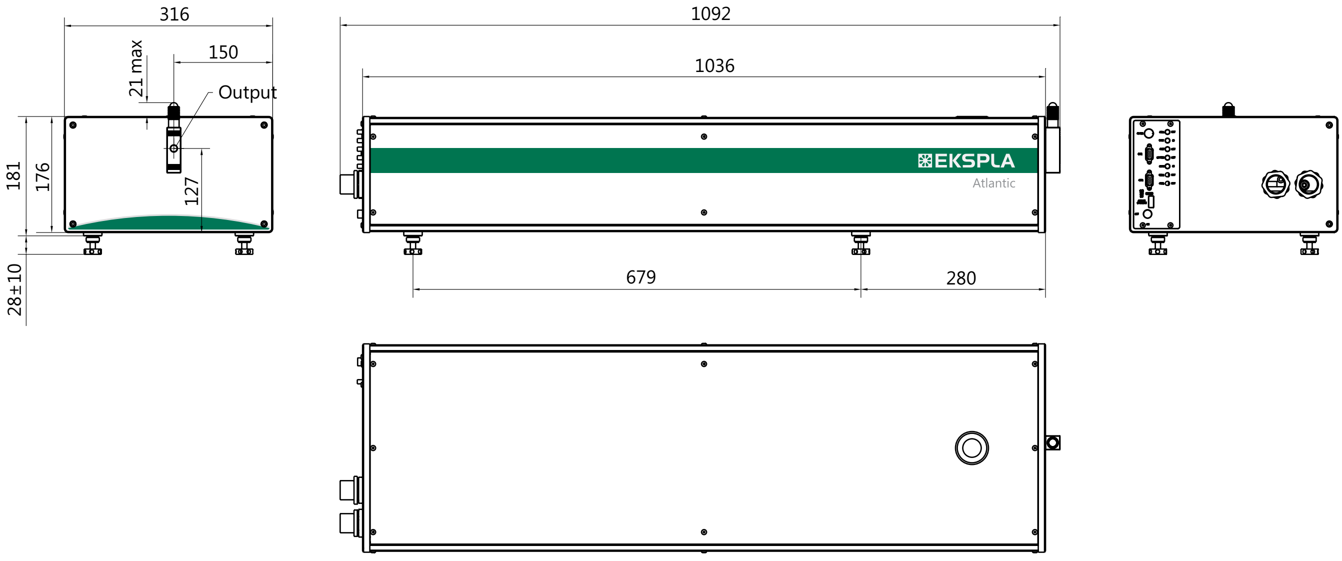
Polymer ablation



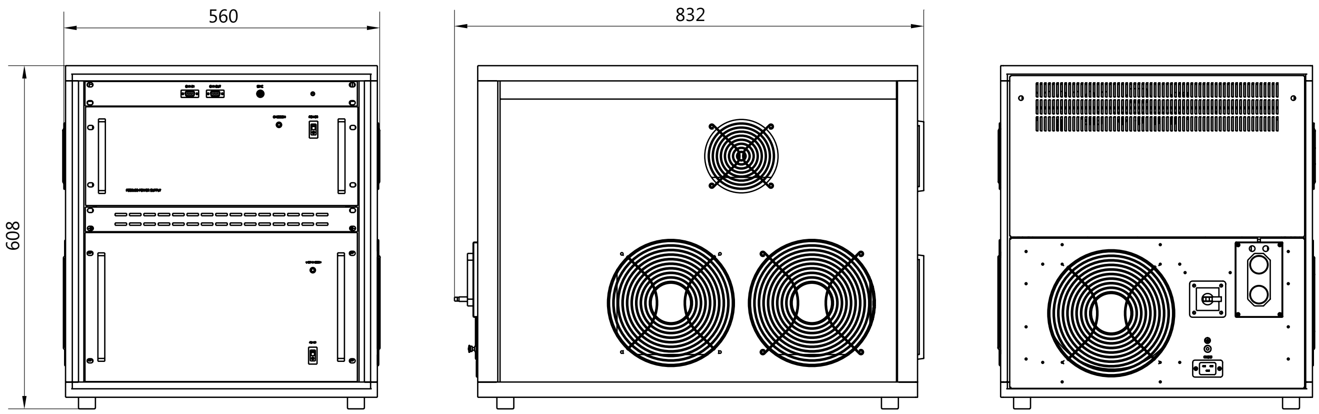
Glass structuring



PMMA structuring



Laser head outline drawing

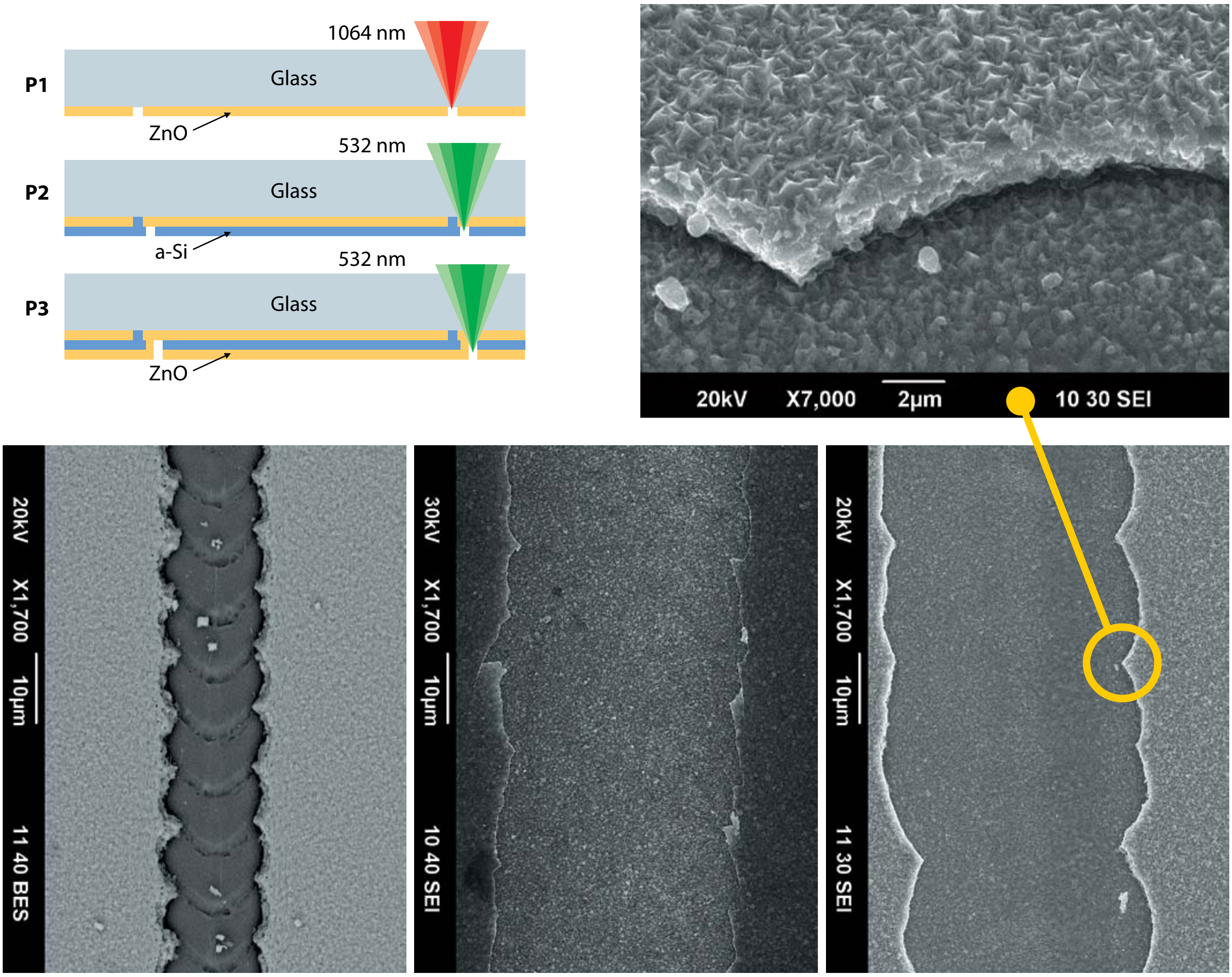


Laser power supply outline drawing

SCRIBING OF a-Si THIN-FILM SOLAR CELLS WITH ATLANTIC LASER

Permanent growth of the thin-film electronics market stimulates the development of versatile technologies for large scale patterning of thin-film materials on rigid and flexible substrates. Efficiency of the thin-film solar cells with a large active area might be maintained if small segments are interconnected in series in order to reduce photocurrent in thin films and resistance losses. Laser scribing is an important step to preserve high efficiency of photovoltaic devices on large areas.

The picosecond laser Atlantic was used to scribe the thin-film layers in ZnO/a-Si/ZnO/glass solar cells. The laser beam was focused through the glass substrate to the solar cells layers as shown in picture below.



P1, 1064 nm, 0.8 W, 100 kHz, 800mm/s — P2, 532 nm, 200 mW, 100 kHz, 900mm/s — P3, 532 nm, 400 mW, 100 kHz, 900mm/s

Fig. 1. Laser back side scribing of Thin-film Solar cells with Atlantic laser

The laser radiation was coupled at the corresponding interface between layers, depending on wavelength of laser radiation, resulting in clean removal of adjusted films in the P1, P2 and P3 processes for interconnect formation. Smoothening of the scribe edges can be achieved by optimization of the beam profile and spot overlap.

CIGS THIN-FILM SOLAR CELL SCRIBING WITH ATLANTIC LASER

Interest in complex multilayered $CuIn_xGa_{(1-x)}Se_2$ (CIGS) solar cells has increased recently because of low production costs and scalability through a roll-to-roll process. Flexible CIGS solar cells have several advantages which make them ideal candidates for space and building-integrated applications.

Efficiency of the thin-film solar cells with a large active area might be maintained if small segments are interconnected in series in order to reduce photocurrent in thin films and resistance losses. Laser scribing is an important step to preserve high efficiency of photovoltaic devices on large areas. There is still no industry-accepted laser scribing process for the CIGS thin-film solar cells.

The main limiting factor to nanosecond laser processing of the multilayer CIGS structures is deposition of molybdenum on walls of channels scribed in the films, and the phase transition of CIGS to metallic state close to the ablation area due to the thermal effect. Both effects create shunts in the photo-electric device and reduce its conversion efficiency. Thermal degradation of the CIGS solar cells starts at temperatures above 350 °C. The processing without damage is possible with ultra-short-pulse lasers.

The picosecond laser Atlantic was used to scribe the thin-film layers in CIGS solar cells with the top contact made of ITO and ZnO. Irradiation with the 355 nm laser radiation has shown better results due to selective energy coupling. Selectivity of the laser ablation with the 355 nm radiation: grains of $CuIn_xGa_{(1-x)}Se_2$ on molybdenum covered by the thin ZnO:Al top-contact. Clean removal has been confirmed by EDS analysis.

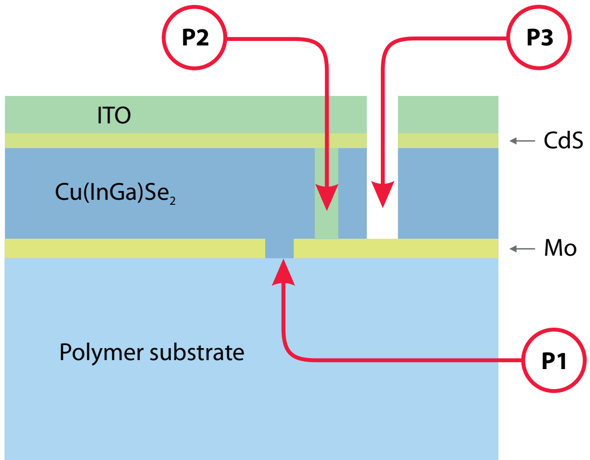


Fig 2. Solar-cell interconnect formed by laser

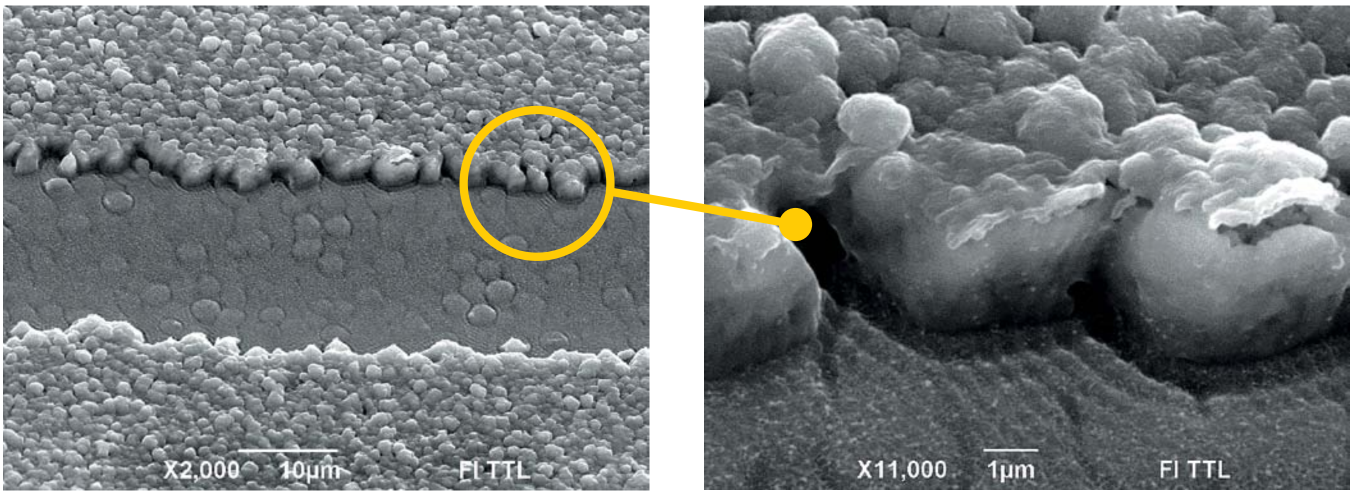


Fig. 3. SEM pictures of P3 scribes in ZnO/GIGS/Mo/PI thin-film solar cells made by picosecond laser Atlantic. Process parameters for 355 nm: 75 mW, 300 mm/s, 1 scan

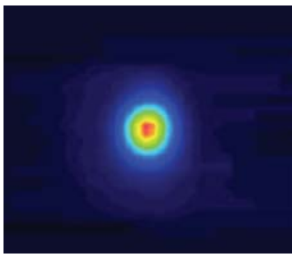
SPECIFICATIONS

MODEL	ATLANTIC 1064	ATLANTIC 532	ATLANTIC 355
GENERAL SPECIFICATIONS			
Wavelength	1064 nm	532 nm	355 nm
Repetition rate range *	Single shot to 500 kHz		
Average output power at 100 kHz	>16 W	>8 W	>4 W
Pulse energy at 100 kHz	>160 µJ	>80 µJ	>40 µJ
Pulse energy contrast	>100:1	>1000:1	
Pulse duration	<10 ps		
Polarization	linear, 100:1		
M^2	<1.5		
Spatial mode	TEM_{00}		
Beam divergence	<3 mRad		
Beam diameter	2 ± 0.5 mm		
Timing jitter in respect to external triggering	12 ns		
Pulse energy stability	<1.5 %	<3 %	
Average power long term drift over 8 hours	2.5 %		3 %
Beam pointing stability	<50 µRad		
PHYSICAL CHARACTERISTICS			
Laser head (W × H × L)	316 × 219 × 1092 mm		
Power supply/pump diode unit (W × H × L)	560 × 608 × 832 mm		
Umbilical length	2 m		
Beam height,	170 mm		
OPERATING REQUIREMENTS			
Ambient temperature	18–27 °C		
Relative humidity (non-condensing)	10–80 %		
Voltage	100 / 115 / 208 / 230 V AC selectable, 50 or 60 Hz		
Power consumption	< 1.8 kW		

* Using integrated E/O modulator.

Specifications are subject to changes without notice.

Typical beam profile
of Atlantic series lasers.
Far field



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