ExciStar™ S-Industrial Series

Heavy Duty Performance - Highest Efficiency

The ExciStar S-Industrial excimer laser from TuiLaser is setting new standards of achievement in industrial applications, especially in critical processes where 100% uptime is essential. The ExciStar S-Industrial world-wide installed base of over 200 units is already hard at work

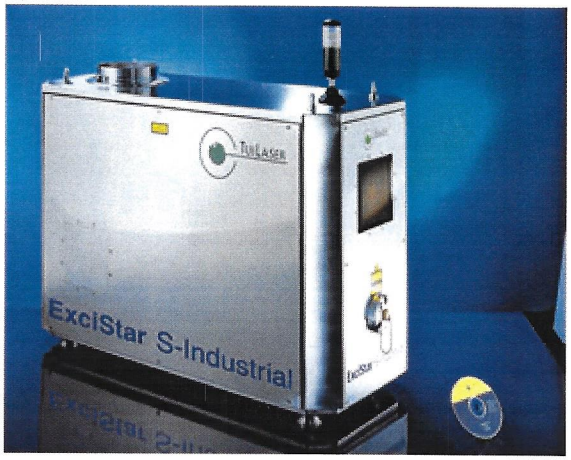
- Microdrilling
- Optics Testing / Inspection
- Micromachining
- Direct Writing

on the mezzo- and microscales.

The success of your UV-laser application depends on high-performance, reliability, easy integration into your process, safety, and fast-response support from your laser supplier. TuiLaser knows that at the core of your business is your process device and its heart is the laser. We have engineered the ExciStar S-Industrial to outperform the competition in every aspect of an industrial laser:

The ExciStar S-Industrial offers the following features:

- Up to 18 mJ at 1000 Hz at 248 nm
- Corona Preionization
- Solid State Switch
- Metal/Ceramic Tube Technology
- High Repetition Rate (up to 2000 Hz)
- Meets SEMI Standards



The ExciStar is easy to incorporate into your existing or planned process station. A single phase power source is all that is necessary for this small-footprint workhorse. Most models do not even require water cooling.

All these features make the ExciStar S-Industrial an extremely reliable, easy-to-use laser, ready to go to work on your application.

Industrial Safety and Standards

A successful company's most important asset is its worker force. The ExciStar S-Industrial is designed to protect everyone on the floor by being the safest excimer laser in its class. The solid-state switch not only provides performance features, it lowers the maximum voltage within the ExciStar to only 1.5 kV. Thyratron-regulated excimers typically have voltages

- One Billion Pulses of Hands-free Operation, without Optics Exchange
- Compact Size (LxWxH: 890 x 380 x 640 mm3)
- Ease of Use
- Long Mean Time Between Failure
- Economical Investment and Minimized Cost of Operation

Whether in terms of energy or average power, long-term stability or beam quality, device footprint or system integration, TuiLaser beats the competition. The high-power output of the ExciStar S-Industrial relies on design features such as the solid-state switch which results in fast rise-time pulses packing more millijoules into each pulse. Corona Preionization creates a more homogeneous discharge and therefore a pulse with excellent spatial characteristics. The metal / ceramic tube design is extremely robust with an extended lifetime due to the use of only the highest quality materials.

These same features provide even more benefits. The temperature-independent solid-state switch is used instead of a Thyratron for delivering power to the discharge. This allows for the "Plug and Fire" capability of the ExciStar - no warm-up time. The solid-state switch also creates a "soft" discharge resulting in excellent pointing and energy stability. We can even customize the spatial and temporal profile of the pulse for applications requiring very specific characteristics.

Other features also enhance the performance of the ExciStar S-Industrial. Precisely balanced motors for the gas-handling system and cooling fan reduce vibrations to a minimum and increase stability. A microprocessor-controlled automated gas-handling system takes the hassle out of the gas supply line.

All this performance is packed into a reliable, small laser which is an economical investment at installation and has extremely modest running costs.

Ease of Use

The ExciStar S-Industrial is the highest performer on the market today in part because it is extremely user friendly. Its small footprint integrates into your lab space, not consume it. The intuitive control panel will have you up and running quickly - no extended "learning curve" reading manuals. You can also remotely control the ExciStar via an RS-232 or RS-422 bus and a WindowsÔ software interface. In either case, external triggering is available through a simple TTL protocol.

up to 10 kV increasing the hazard presented to operators.

Furthermore, the ExciStar uses two levels of error trapping for added safety (and process control): the first can display a series of error codes allowing the technician to quickly evaluate any problem within the system before opening the laser. Second, should a hazardous condition develop inside the laser, an error signal is generated shuts down the system automatically.

The handling of halogen gases is also a primary safety concern. The discharge tube - constructed from metal and ceramic components - is supported by a newly reengineered gas management system. We have incorporated a microprocessor-controlled, fail-safe manifold to ensure a safe work environment. A specially-designed vacuum pump works with a halogen exhaust filter to ensure no halogen leakage into the environment. Premixed laser gases not only mean more regularity in laser performance, but also reduce risks to the operator.

SEMI certification (Semiconductor Equipment and Materials International) is an inroad to worldwide acceptance of the safety of your manufacturing equipment. ExciStar lasers meet SEMI standards of safety and reliability and have been incorporated in many SEMI-certified process devices. They have also obtained FDA, UL-CSA and IEC 61010 certifications as well. These endorsements demonstrate that our commitment to safety and performance is a top priority at TuiLaser.

Quality and Reliability

High performance, ease of use, and safety are of little value if your laser is constantly under repair. This is why our excimer lasers are built to be rugged and reliable. Our exacting standards result in long mean time between failures (MTBF). Once again, the Corona Preionization enhances performance. Designed without ionizing pins, hefty electric fields which can cause arcing are avoided. Instead, working in conjunction with the solid-state switch the Corona Preionization produce a "soft" discharge which not only produces better beam quality, it results in less wear and tear on the system and less down time. Furthermore, this soft discharge and optimized electrical system mean no misfiring or prefiring of the discharge. Every shot arrives on time - you can count on it.

The robust metal / ceramic tube design, along with a

The ExciStar S-Industrial is "Plug and Fire." This means effectively no warm-up time at the beginning of the work cycle - whether that is every morning, every Monday or only at service intervals. The ExciStar delivers the same power and spatial characteristics from the first pulse to the last.

Other enhancements also make the ExciStar S-Industrial extremely reliable. A simple, modular design separates the system into intuitive components. This method optimizes your layout options and makes servicing the laser as easy as possible. The control electronics have been reduced to a pair of easily-removable circuit boards making failure diagnosis and repair fast and efficient. All the low-voltage control and feedback signals are passed from one module to another via a single five-pin D connector, making assembly and disassembly quick and easy. Extensive troubleshooting documentation is available to minimize downtime.

An efficient dust-removal system and an optimized discharge, combined with the all metal and ceramic discharge tube result in a very clean discharge despite the corrosive properties of halogen gases. The optical windows actually have a longer lifetime than the tube itself, thus obviating the need to clean or service them. The result is less down time and higher productivity with a TuiLaser.

ExciStar™ S-Inustrial - Technical Specifications

particulate filter incorporated in the gas handling system prevent ablated materials from depositing on the optical surface, thus virtually eliminating down time for cleaning and replacing optical components.

Many components used in the ExciStar have been awarded SEMI certification of quality and performance. The system as a whole is SEMI certified. This is the industry-accepted mark of approval for reliability and performance. Legendary German engineering and pride of craftsmanship go to work for you in the design and manufacture of every TuiLaser.

The ExciStar S-Industrial excimer laser is a high-performing, easy-to-use, reliable laser with roots traceable to SEMI, FDA and other standards bodies. The ExciStar provides all of this with excellent performance:

Laser Medium	F_2	ArF	KrF	XeCl	XeF
Wavelength	157 nm	193 nm	248 nm	308 nm	351 nm
Tube Design	FutureTube™	FutureTube™	FutureTube™	FutureTube™	FutureTube™
High Voltage Switching Technique	Solid State Switch	Solid State Switch	Solid State Switch	Solid State Switch	Solid State Switch
Preionization Technique	Corona Preionization	Corona Preionization	Corona Preionization	Corona Preionization	Corona Preionization
Energy max.[3]	1.5 mJ	12 mJ	18 mJ	12 mJ	upon request
Average Power max.					
S-Industrial 200	250 mW	2 W	3 W	2 W	
S-Industrial 500	625 mW	5 W	8 W	5 W	
S-Industrial 1000	1000 mW	10 W	16 W	10 W	
Repetition Rate max.	200 Hz 500 Hz 1000 Hz	200 Hz 500 Hz 1000 Hz	200 Hz 500 Hz 1000 Hz	200 Hz 500 Hz 1000 Hz	200 Hz 500 Hz 1000 Hz
Pulse Duration	15 ns (FWHM)	12 ns (FWHM)	15 ns (FWHM)	12 ns (FWHM)	12 ns (FWHM)
Energy Stability [4]	σ<3 % (Standard Deviation)	σ < 3 % (Standard Deviation)	σ <3 % (Standard Deviation)	σ < 3 % (Standard Deviation)	σ < 3 % (Standard Deviation)
Beam Dimensions	3 mm x 3 mm (FWHM)	3 mm x 6 mm (FWHM)	3 mm x 6 mm (FWHM)	3 mm x 6 mm (FWHM)	3 mm x 6 mm (FWHM)
Beam Divergence	<1.5 mrad x 1.5 mrad (FWHM)	< 1 mrad x 2 mrad (FWHM)	< 1 mrad x 2 mrad (FWHM)	< 1 mrad x 2 mrad (FWHM)	< 1 mrad x 2 mrad (FWHM)

2) All specifications are typical data and subject to change without notice in order to provide the best product possible
3) Allow 15 % reduction of output energy and power, if laser is equipped with energy stabilization module
4) Measured at max. high voltage (1500V)

PHOTONICS SPECTRA

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Applications

Using photonics to solve problems of the real world

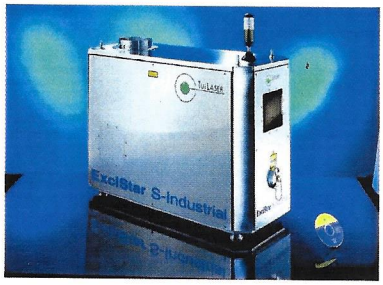
Excimer Laser Powers Phase-Shifting Interferometer

An interferometer that promises to improve the characterization of phase-shift masks for use in semiconductor lithography has been developed by researchers in Germany. The instrument, which uses an ArF laser as an illumination source, takes several pictures of the mask with a different relative phase shift and calculates the phase distribution.

The continuing trend toward more powerful integrated electronic circuits requires manufacturers to increase feature densities on a chip of a given size by decreasing the size of the circuit structures. To enable them to do so, engineers are developing resolution enhancement techniques such as the application of masks that employ controlled phase shifts to improve the pattern created on a substrate. Interference produces intensity values of zero between structures that would be inseparable if amplitude masks had been used.

This requires that the phase shifts creating the interference patterns be generated and measured very accurately, typically expressed in terms of the phase difference introduced between adjacent details of the mask. Heretofore, this has been done indirectly, using atomic force microscopy and other profiling techniques that measure variations in the thickness of the mask.

The new method. devised by scientists at Friedrich Alexander University of Erlangen-Nuremberg in Erlangen, in collaboration with TuiLaser AG of Munich, both in Germany, takes the direct approach. The optical setup consists of a UV microscope operated in transmission mode with two surface relief gratings - Ronchi gratings - in the imaging path. A common-path arrangement is used. rather than separate object and reference paths, to ease issues of stability, vibration and air turbulence and to minimize losses due to absorption by other components in the optical path. The gratings generate two laterally sheared wavefronts that carry phase information to the object being characterized.



The introduced shear depends on the distance between the phase gratings, and to introduce large shears, a complex coherence is prepared. This is done using a structured illumination source, in which a pattern is added to the lateral beam profile of the laser source. The technique reduces unwanted interferences and allows for a high contrast ratio and minimal light loss. Under these conditions, the phase step introduced by a phase-shift mask structure can be measured with a high degree of accuracy.

At the short wavelengths used, a high degree of stability and sensitivity is critical. At 193 nm, for example, the phase shift induced by a feature with a height of 1 nm results in an intensity change of only 1.65 percent.

The performance of the illumination source in the system also is critical. The laser must display a homogeneous spatial beam profile, low shot-to-shot noise and high long-term stability in both continuous and burst modes. TuiLaser's ExciStar 5-500, an industrial-grade 193-nm ArF laser optimized for photolithography applications, uses solid-state switching and corona preionization of the discharge to meet these requirements.

Another design consideration is the need for reliable synchronization between the laser and the CCD that collects the phase information returning from the mask. In the interferometer, this is done through a software driver that ensures that the same number of laser pulses is averaged for each CCD frame. On the hardware side, this means that the laser trigger must display very low jitter.

Tests of the inspection system confirm that direct phase measurement offers accurate results because the measurements are performed at the design wavelength, avoiding mask and wavelength conversion errors. It provides an absolute accuracy of the phase measurement of better than $2\pi/280$ (i.e., <0.7 nm at 193 nm) and a reproducibility of $2\pi / 1150$ rms (i.e., <0.17 nm at 193 nm).

The technique is used as part of Carl Zeiss lithography systems and as an extension for 157-nm applications to support enhancement of phase-shift mask resolution for even smaller structures. It also may find application outside semiconductor manufacturing.

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