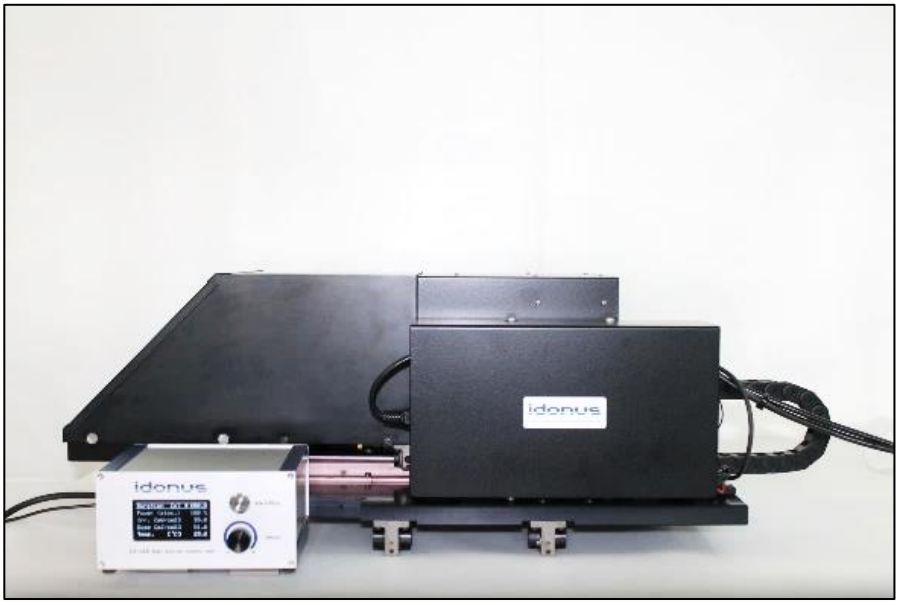




APPLICATION NOTE

Retrofitting mercury-based mask aligners with idonus UV-LED light source

Mask aligners and other UV exposure equipment are valuable workhorses for many research and production clean rooms. As their mercury-based light source are becoming obsolete, their alignment stage can be operational for many years. For this reason, idonus offers retrofitting services: upgrading the mercury-based light source to new UV-LED light engines. This document presents the process with a practical example.

idonus
creative engineering and manufacturing

Edited: March 2020
by idonus sàrl, Switzerland
www.idonus.com

High-power UV-LED source

Mercury free

Our UV-EXP light source integrate high-power Light-Emitting Diodes (LED) to generate UV light. In comparison with the mercury (Hg) lamps currently used in traditional systems, LEDs have many advantages which are triggering an industry-wide transition. In the table below we have highlighted the main technical features of LED technology, while the spectral distribution of the 4 wavelengths of interest to UV photolithography are introduced in figure 1.

The 365 nm UV-LED offers best versatility and is our recommended choice for most of the applications. Should the process efficiency be the critical parameter, the 385 nm is the best choice for certain photoresists.

LE-2X option allows ×2 LEDs to be installed on the exposure unit which can be manually switched in a few seconds when needed.

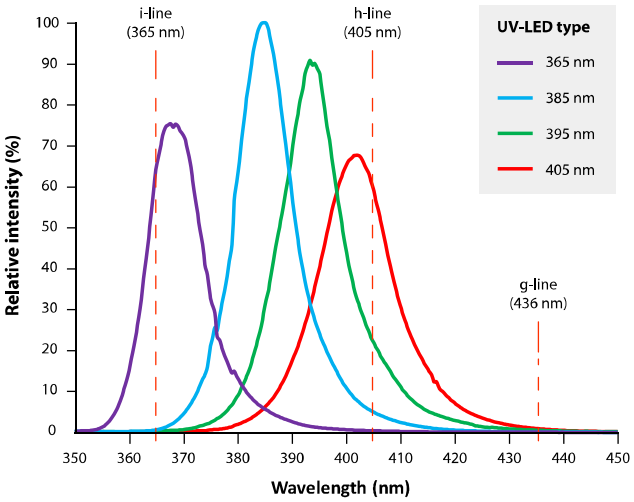


Figure 1: Spectral distribution of our UV-LEDs. The i-, h-, and g-lines that are characteristic of Hg spectrum are indicated for comparison purpose.

For recommendations regarding the UV-LED wavelength for your process, please refer to our technical note: *Photolithography exposure process with UV-LED* or contact our sales engineers.

	idonus high-power UV-LED	Mercury-based UV light sources

Light spectrum	• Each LEDs have a quasi-gaussian distribution about a single designed wavelength (dual wave-length possible):
	  • 365 nm
	  • 385 nm
	  • 395 nm
	  • 405 nm
	• No energy wasted outside the needed wavelengths: minimum sample heating
	• Necessary dose can be calculated for each application and precisely controlled
		• Broad Hg spectrum with 3 peaks of interest to photolithography:
		  • i-line (365 nm)
		  • h-line (405 nm)
		  • g-line (436 nm)
		• Unwanted spectrum energy absorbed by substrate as heat or filtered

Lifespan [a]	> 10'000 h (actual exposure time)	Approx. 500 to 1000 h
Stability in time	• No warm-up time required (instant ON) • No shutter • Performance variable with temperature (approx. -10% at maximum operating temperature, control feedback loop compensated)	• Warm up period required: the lamp is kept on during day and exposure controlled by shutter • Deterioration of performance during lifetime with unpredictable effects
Environment impact	• No hazardous materials • High energy efficiency	• Contains hazardous material (Hg) • Low energy efficiency
Safety	• No safety concerns	• Risk of explosion and contamination

[a] The LED industry has standardized the definition of LED lifetime. For example, L70 rated life gives the number of operating hours until the LED is emitting 70% of its initial light output. The lifespan shown in the table is indicative. Note that mercury-vapor lamp must be turned ON continuously, while LEDs are only turned ON during exposure.

Retrofitting example

The procedure of retrofitting a Karl Suss MA6 Mask Aligner (figure 2) with idonus UV-EXP-LEx1 LED light source is illustrated below step by step.

Similar procedure applies to other mask aligners or exposure equipment.

The procedure can be carried out completely by your technician upon receiving the complete installation manual from idonus. Alternatively, your technician could only disassemble the light source module and send it to us for factory retrofitting. Of course, the process could be also completely performed by our technicians on site.

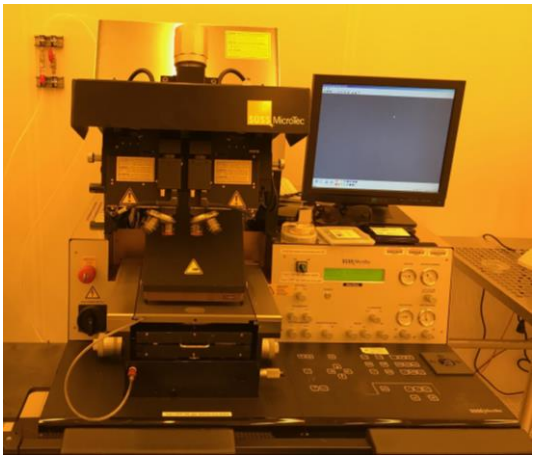
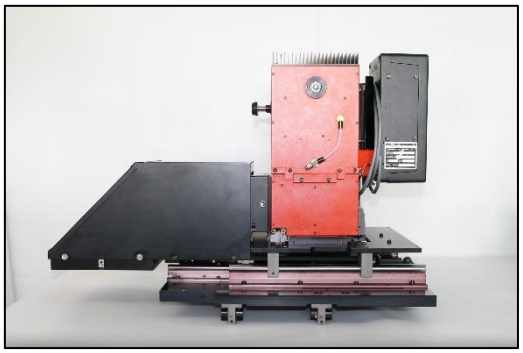


Figure 2: Photograph of a mask aligner Karl Suss MA 6

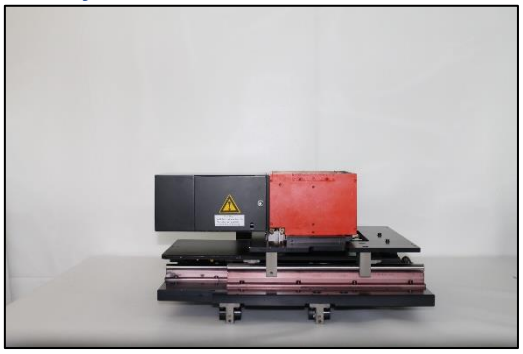
A. Disassembly



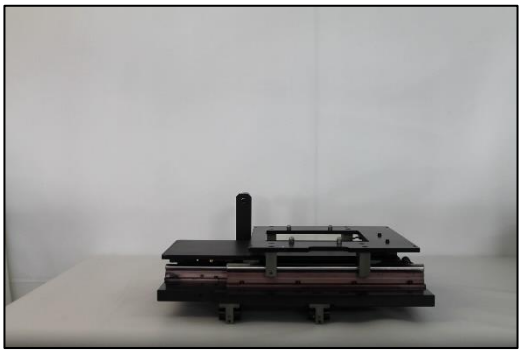
A1: Disassembled light source module of Karl Suss MA6, model 260MS022



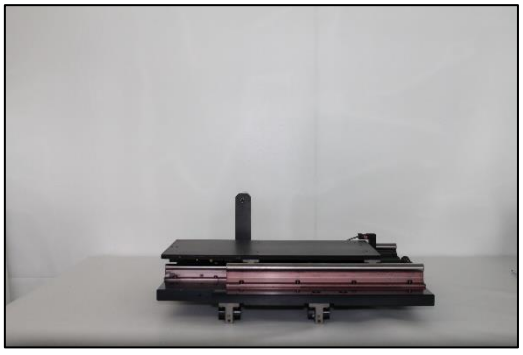
A2: Front lens holder removed



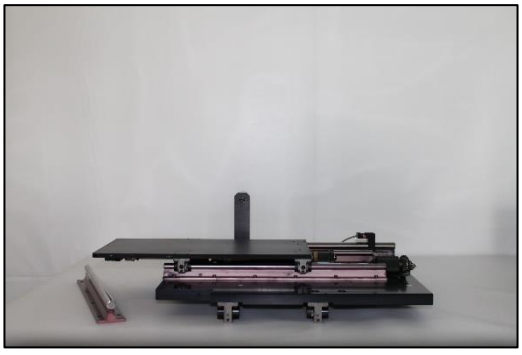
A3. Mercury-vapor lamp removed



A4. Mechanical structure without optics



A5. Mechanical structure without 2nd stage



A6. Side rail removed (located to the right for the operator)

Retrofitting process

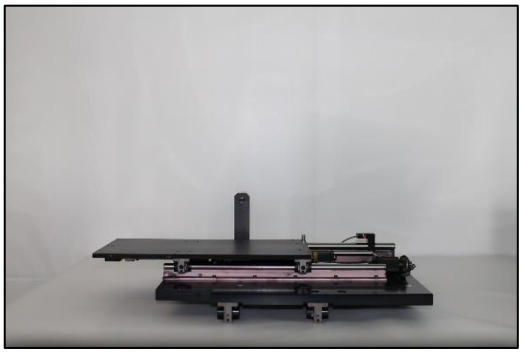
Components needed for assembly stage:

- Original mechanical structure from the MA6: unused elements have been removed
- Original "front lens holder" from the MA6 (UV400 front lens, 45° first surface mirror, metal cover, **×4 screws**)
- *UV-EXP-CU* Control Unit, 12 VDC power supply and cable, **×4 screws**
- *UV-EXP-LE* Light Engine + *UV-SENS-GaP* sensor
- Cover for the high-power supply, **×2 screws**
- Cable carrier and its fixing bracket, **×2 screws**
- High-power supply module with all wirings to the electric terminal, **×2 screws**

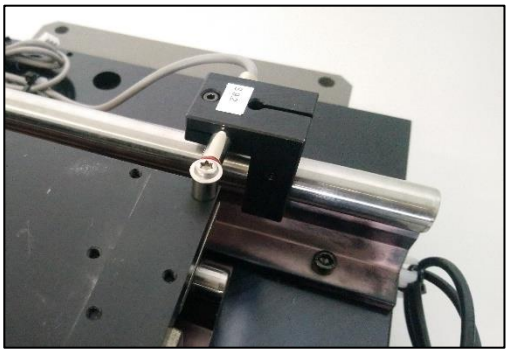


Figure 3: Elements needed for assembly

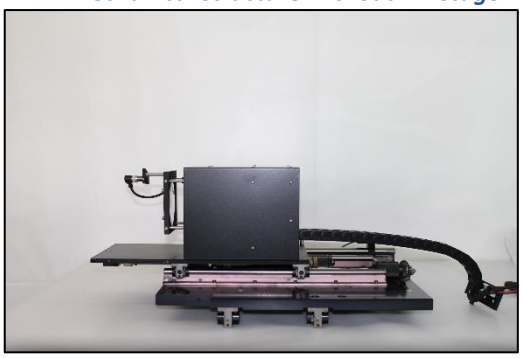
B. Assembly of idonus UV-EXP-LE (1/3)



B1. Mechanical structure without 2nd stage



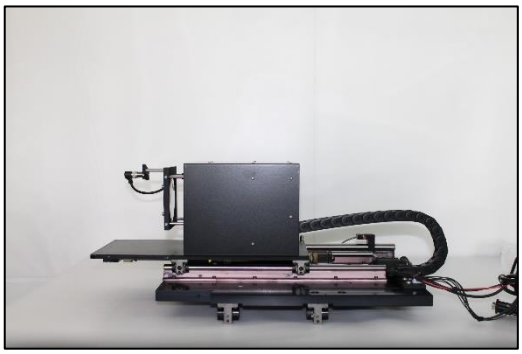
B2. Secure the metal holder and the rear sensor



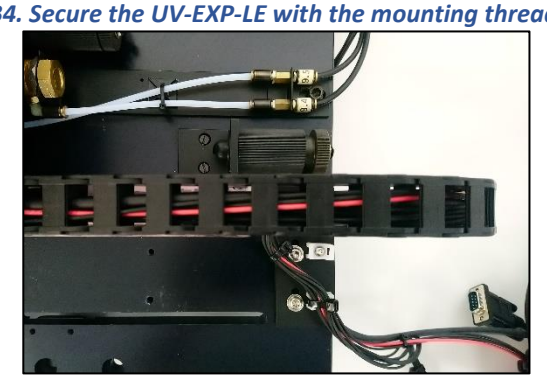
B5. Mount the UV-EXP-LE



B4. Secure the UV-EXP-LE with the mounting threads



B5. Attach the cable carrier



B6. detail of the attached cable carried

Component re-use

- In most retrofitting performed by idonus, the front lenses, mirror and their housing can be re-used
- If they are damaged, idonus also supplies complete light sources for various illumination sizes
- Unfortunately, the homogenisation optics of older mask aligners are not of enough quality for use with LED technology and therefore cannot be reused.
- Our retrofitting kit comes equipped with premium homogenizer optics, achieving even better exposure performance than the original equipment

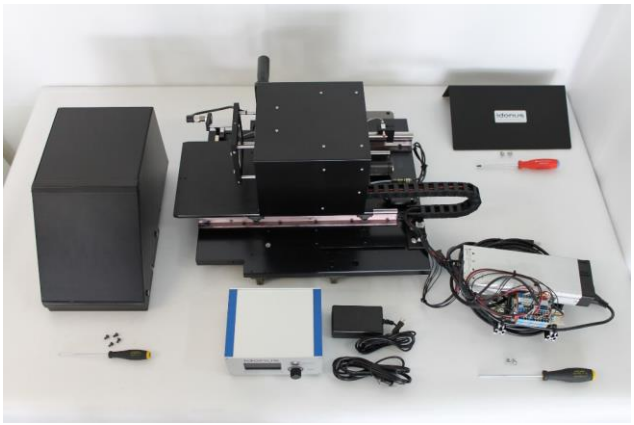
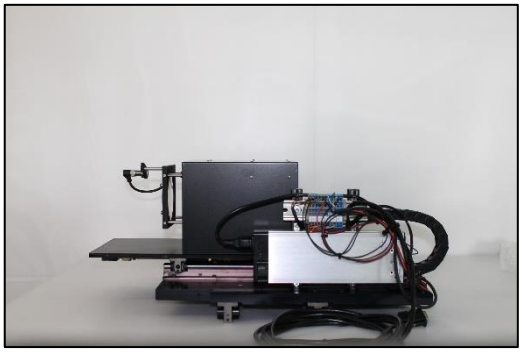
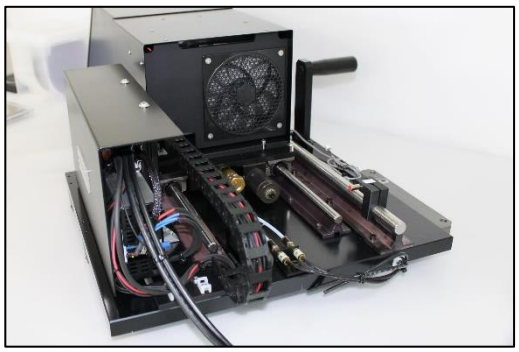


Figure 4: Elements after partial assembly

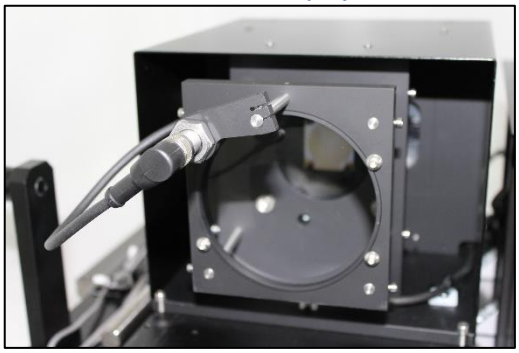
C. Assembly of idonus UV-EXP-LE (2/3)



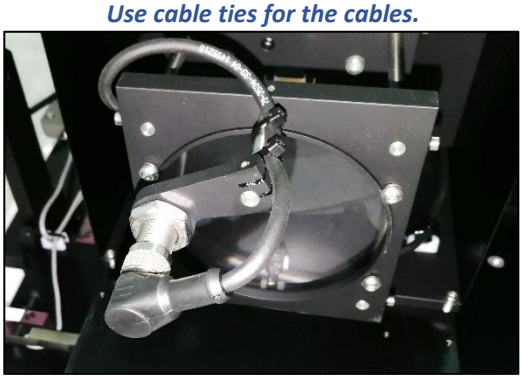
C1. Install the power supply using the treaded holes from the side rail (A6)



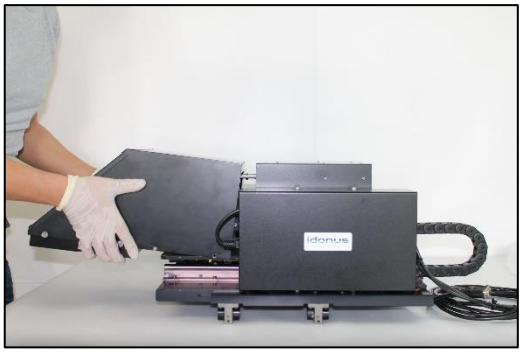
C2. Enclose the power supply and cables with the cover. Use cable ties for the cables.



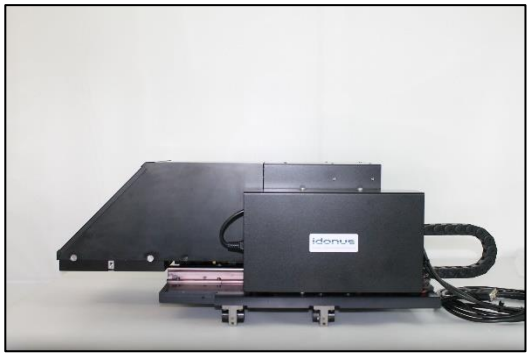
C3. Attach the UV-Sens-Gap with the provided holder



C4. Ensure proper position and secure the cable with ties



C5. Re-assemble the front lens holder



C6. Result of the retrofitted exposure module

Improved Control

- Exposure parameters are controlled via our UV-EXP-CU Control Unit:
  - **Duration**: controls the exposure time from 0.1 to 600s
  - **Power**: controls the current supply to LED between 10 and 100%
  - **Irradiance**: controls the LED irradiance via our UV-Sens-Gap sensor between 5 and 50 mW/cm2
  - **Dose**: controls the total dose (irradiance x exposure time) from 10 to 9'000 mJ/cm2
- Unlike mercury lamps, LED technology does not need shutters. The exposure is controlled electronically by powering ON or OFF the LED.
- The trigger for exposure (controlling the shutter) of your old equipment can be connected (if wanted) to our control unit for a seamless integration.
- The retrofitted exposure module can now be installed back in your original equipment

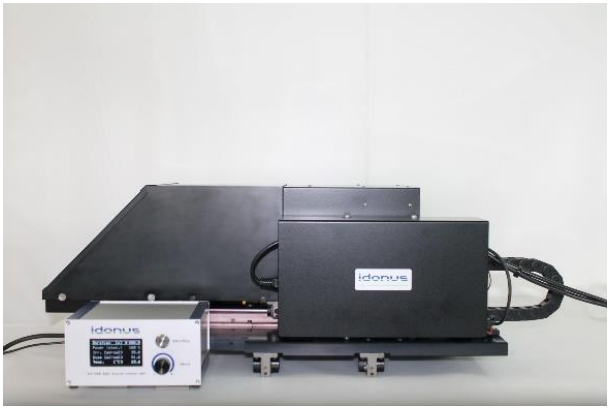


Figure 5: Retrofitted complete exposure module



Figure 6: Detail of UV-EXP-CU Control Unit

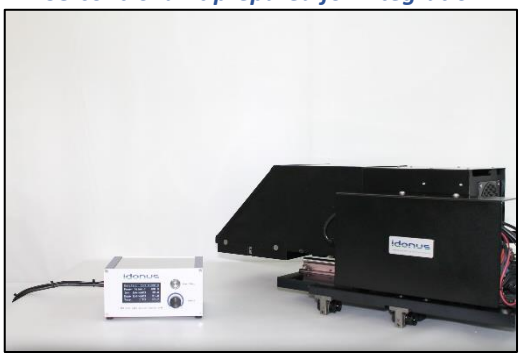
D. Final integration with the control unit (3/3)



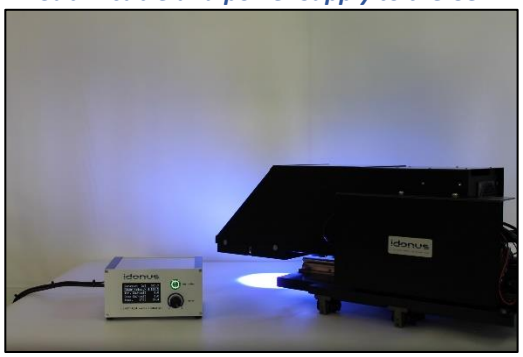
D1. The retrofitted exposure module and Idonus UV-EXP-CU control unit prepared for integration



D2. Connect the exposure module to the control unit via Sub-D cable and power supply to the CU.



D3. Functional exposure module

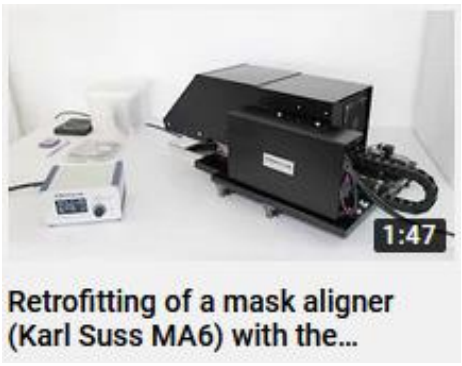


D4. Exposure test
(!! Do not test without eye protection)

LED Retrofit

- As of March 2020, Idonus has performed retrofitting of the following equipment:
    - Karl Suss MA6
    - Karl Suss MA6/BA6
    - Karl Suss MJB4
    - Karl Suss MJB3
    - EVG620
    - Neutronix Quintel NXQ8000
- Retrofitting kits are readily available for the above-mentioned models, in which case the process can be straight forwardly performed by yours or our service engineers.
- If your equipment in need of upgrade is not in the list above, we recommend shipping the exposure module to our premises for retrofit. Alternatively, the process can be carried out with our support and collaboration of your technician.
- If retrofitting is not your solution of choice, idonus also offers new and cost-effective solutions of our own innovative design for exposure and alignment.

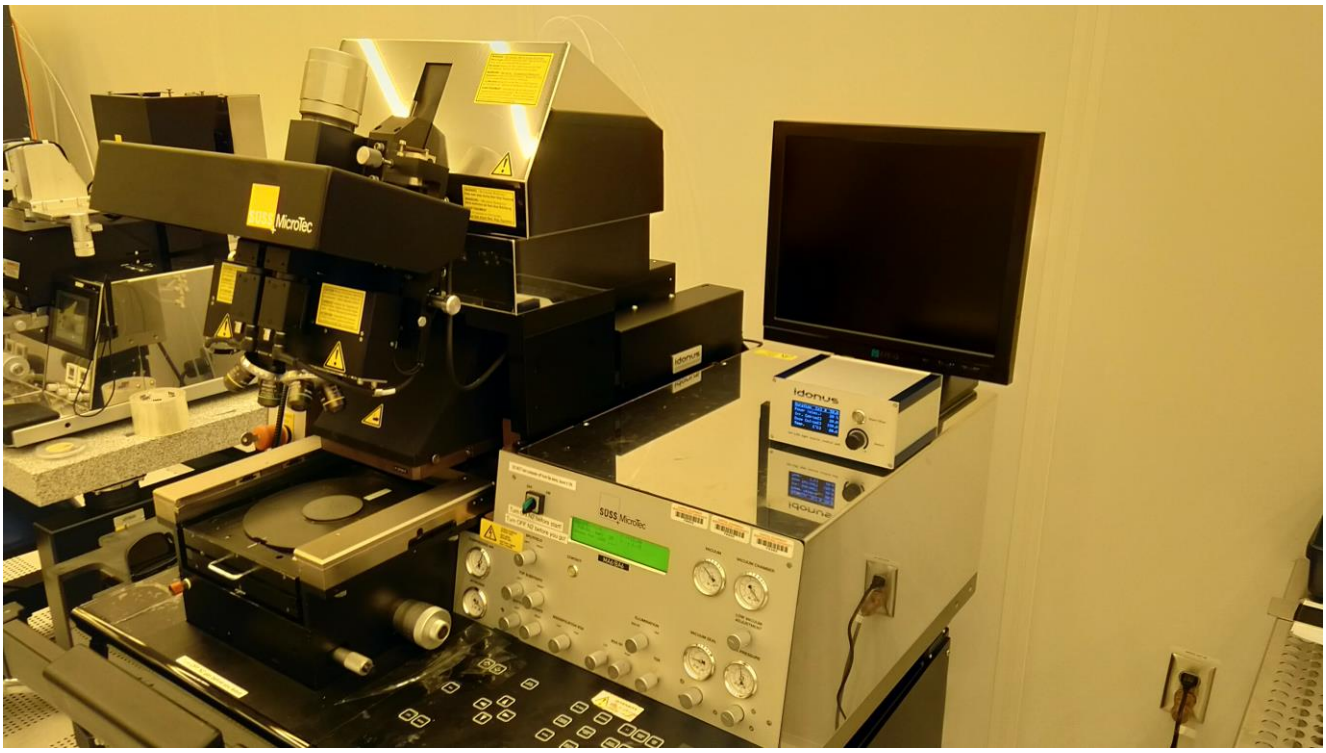
Watch our Retrofitting video:



YouTube http://youtu.be/8JMylWFsvMg

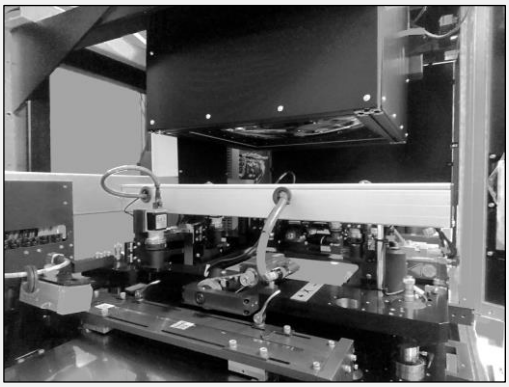
Why considering an upgrade?

- Extend the life of your equipment
- Increase the stability and repeatability of your process
- Lower your maintenance costs
- Lower your electricity consumption
- Decrease your environmental impact



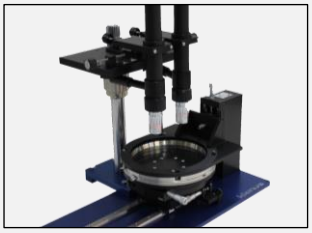
Retrofitted equipment installed and functional at Northwestern University, USA

Creative engineering and manufacturing • Our engineering team is accustomed to developing products according to client's needs. In-house machining and assembling facilities shorten the time from concept to finished products.

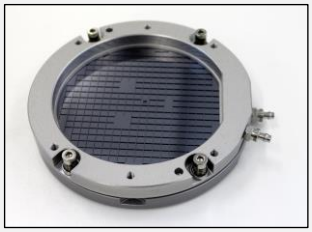


Customized UV-LED exposure system installed on a roll-to-roll machine

Visit our website to have an insight into our other products and activities. Contact us for further technical information and to obtain a quotation.



Double image microscope



A model of wafer chuck

About Idonus

Founded in 2004, Idonus is a Swiss company that develops and manufactures equipment for the MEMS and watchmaking industries. Our product portfolio includes UV-LED exposure systems for photolithography, IR microscope for wafer inspection and vapor phase chemical etcher for silicon-based devices. We also provide ion implantation services and machines for the surface treatment of materials.

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