USHIO's Product Portfolio for Semiconductors

USHIO INC. has been delivering UV lamps and halogen lamps to the global semiconductor industry for more than 45 years. Starting with these light sources, USHIO has provided a wide range of semiconductor fabrication equipment, subsystems and components, such as projection, contact, and proximity lithography tools, WLP steppers, excimer irradiation units, UV curing units, and mask cleaning systems.

Unveiling the Two Latest UX4-LEDs Series Products

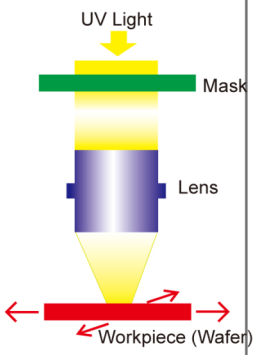
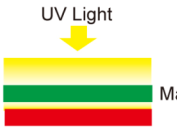
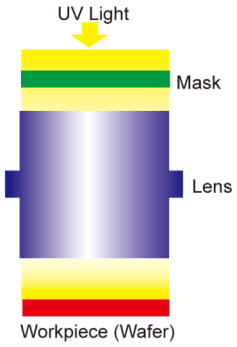
At SEMICON West 2011, USHIO unveils the two innovative products for mass-production of high-brightness LEDs: the 200-mm wafer full-field projection lithography tool UX4-LEDs FFPL 200 and the 150-mm wafer laser lift-off system UX4-LEDs LLO 150.

UX4-LEDs Series Platform

UX4-LEDs FFPL 200

As lithography tools for manufacturing LEDs, conventional i-line steppers and contact aligners have been used. However, stepper systems are expensive and their throughput is relatively low, and while contact aligners have fairly high throughput, the mask or wafer may be damaged because they are put into contact during exposure process.

In order to eliminate these challenges that most of LED manufacturers have faced, USHIO succeeded in developing the full-field projection lithography tool UX4-LEDs for processing up to 150-mm wafers last November. Leading LED manufacturers in Japan, Korea, Taiwan, and China have already introduced this 150-mm model. The UX4-LEDs FFPL 200 is the 200-mm wafer model with the same system configuration as the 150 mm model on USHIO's field-proven UX series platform.

Exposure Method		Stepper	Contact Exposure	UX4-LEDs FFPL 200
		Projection	Contact	Projection
		Step & Repeat	Full-field	Full-field
Performance	Tact（ø200 mm）	× Theoritically 100 wafers/hour *1	○ Theoritically 100 wafers/hour *2	◎ 120 wafers/hour
	Mask Damage	◎ No Contact	× ・Scratch caused by wafer warpage ・Occurrence of continuous defects ・Mask needs to be cleaned and replaced	◎ No Contact
	Resolution	△ 1 μm L/S or less Defocus may occur	△ 1 through 5 μm L/S Resolution lowers depending on the distance between the mask and wafer	○ 3 μm L/S
	Overlay Accuracy	○ 1 μm or less	△ ±1 μm Overlay accuracy lowers depending on thermal expansion of the mask	○ ±1 μm
Wafer Size Conversion（ø50／100／150／200 mm）		× To be customized	× To be customized	◎ Automatically Enable
Exposure Mechanism		 Allows longer process time due to a step-and-repeat exposure of each chip on a wafer.	 No lens is used but the mask and wafer are put into contact. Thus, both may be damaged to lower the yield.	 Allows damage-free full-field exposure to shorten the process time.

*1 : Due to wafer bow, the throughput may be reduced to 30% or 30 wph.

*2 : Due to the need for mask cleaning, the throughput may be reduced to 75% or 75 wph.

The UX4-LEDs FFPL 200 is mounted with a full-field projection lens of 200 mm in diameter on the common UX4-LEDs platform to enable full-field projection exposure of a 200-mm wafer; it can achieve a high throughput of 120 wafers per hour. Unlike the stepper systems that lower their productivity as the wafer becomes larger, the UX4-LEDs FFPL 200 uses the full-field projection method to enhance its productivity by increasing the wafer size. Therefore, it allows further enhancement of the productivity and reduction of the Cost-of-Ownership (CoO) in the LED lithography process.

200-mm Full-field Projection Lens

UX4-LEDs FFPL 200 Specifications

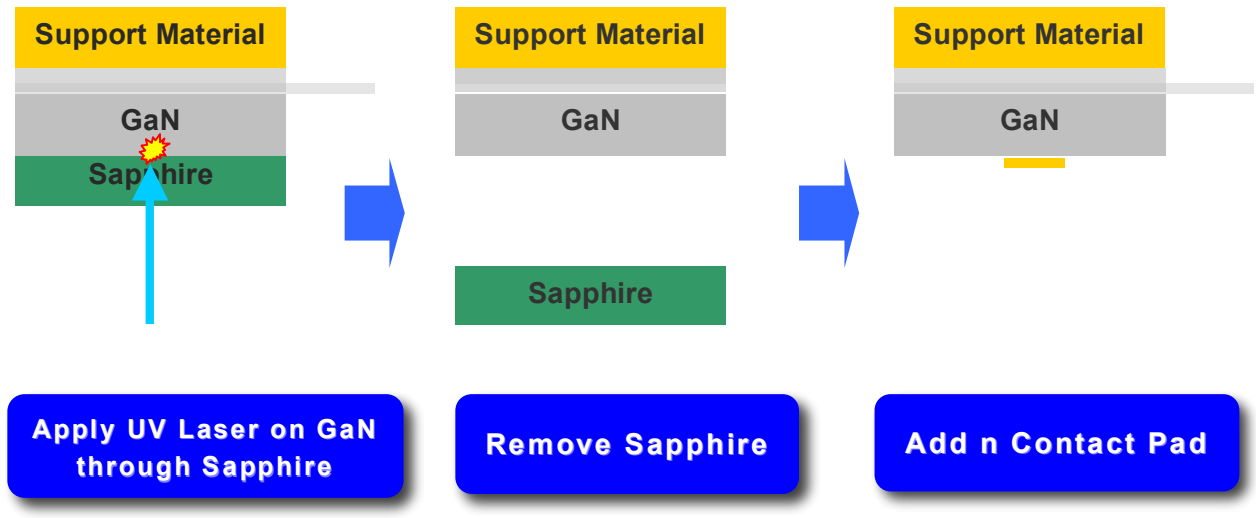
Resolution:	3 µm L/S
Wavelength:	365 nm
Overlay Accuracy:	Top 1 µm, Bottom 1 µm
Throughput:	120 wph in any wafer size
Wafer Size:	100 mm, 150 mm, and 200 mm, selectable
Wafer Transfer Method:	Automated wafer handling on the UX4-LEDs platform

UX4-LEDs FFPL 200 Features

- Designed to automatically handle size conversion for wafers of up to 200-mm
- Completely non-contact so as to cause no mask damage
- Special alignment technology for low-visibility alignment marks
- Large depth of focus and special wafer chucking to cope with warped wafers
- Modular platform for future upgrade
- Optional backside alignment function to support LED wafer-level-packaging applications

UX4-LEDs LLO 150

GaN-based semiconductors are widely used for optoelectronic devices, such as LEDs. These devices were grown heteroepitaxially onto dissimilar substrates, such as sapphire or SiC, because of difficulties in the growth of bulk GaN. The sapphire is the most commonly used substrate. However, due to the poor electrical and thermal conductivity of a sapphire substrate, the device process steps are relatively complicated compared with other compound semiconductor devices. Therefore, GaN optoelectronics devices fabricated on an electrically and thermally conducting substrate by separating the sapphire substrate are most desirable. The LLO-GaN LEDs were fabricated by lifting off the GaN LED wafer structure grown on the original sapphire substrate by a KrF excimer laser at 248 nm wavelength.



Laser Lift-Off Process Conceptual Diagram

Today, High-Brightness (HB) LEDs require more power at less cost. In order to meet these conflicting needs, the LED chips have become larger and the vertical structure has been introduced to achieve more power, while wafer-level packaging, reuse of sapphire wafers, and automated processing have been introduced to reduce the manufacturing cost.

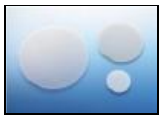
Increasing the power by using:

Vertical Structure

Larger Chips

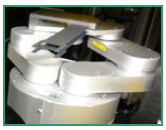
Reducing the manufacturing cost with:

WLP



Reuse of Sapphire

Automated Process



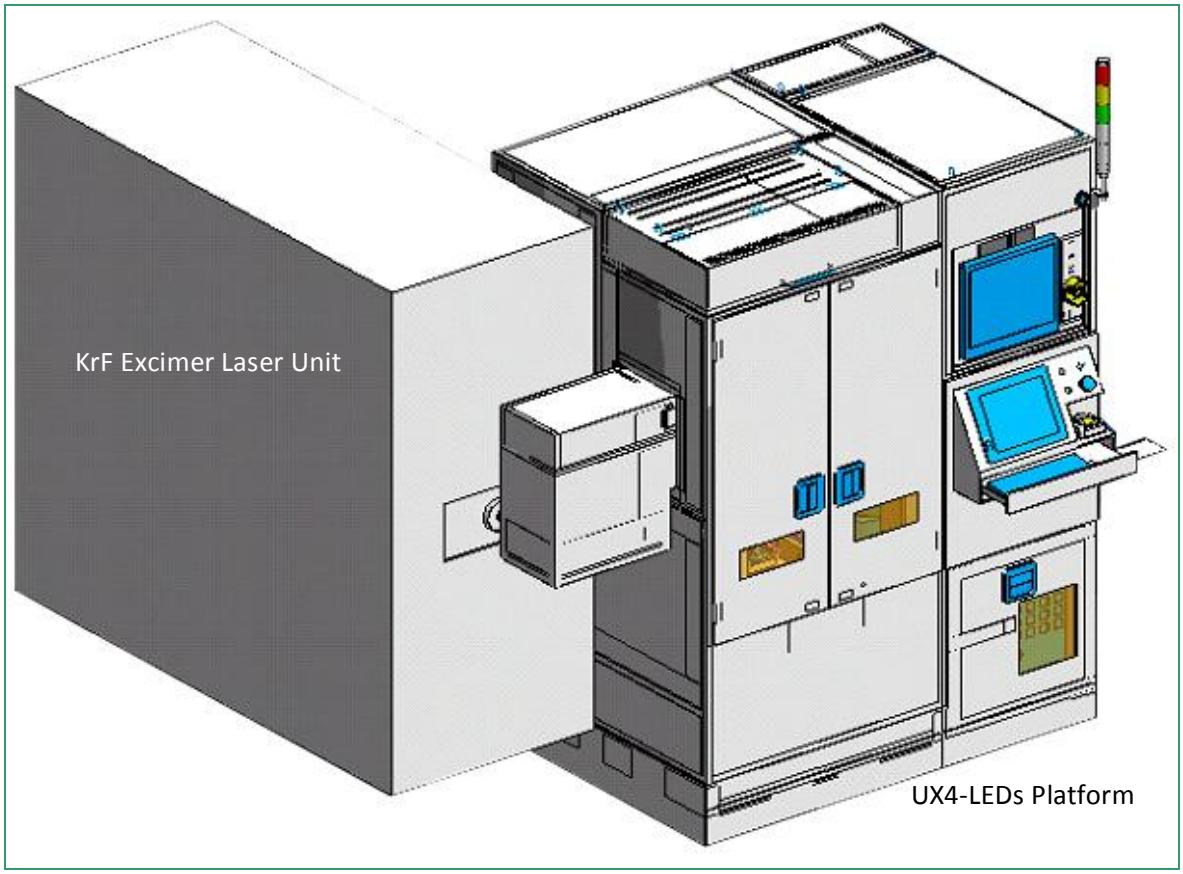
The laser lift-off (LLO) technology, for stripping a GaN film from a sapphire substrate, is indispensable to increase LED brightness and reduce its manufacturing cost. Leveraging the field-proven photolithography excimer laser, well known for high repetitive frequency and high stability as well as proven DUV optical technologies, USHIO has succeeded in developing the UX4-LEDs LLO 150 laser lift-off system that achieves both high yield and high throughput. This system also contributes to a significant reduction of the LED manufacturing cost by allowing reuse of a sapphire substrate because the GaN film can be stripped from the entire sapphire substrate surface.

UX4-LEDs LLO 150 System Configuration

The UX4-LEDs LLO 150 consists of the UX4-LEDs platform and the KrF excimer laser, both of which have been field-proven under a high-volume manufacturing environment and have achieved high performance as well as high reliability.

UX4-LEDs LLO 150

LLO System for HVM of HB LEDs



UX4-LEDs LLO 150 Specifications

Wafer Size:	Up to 150 mm
Laser:	KrF excimer laser 248 nm
Stage:	Mechanical stepper stage with laser interferometer
Wafer Transfer Method:	Automated wafer handling on the UX4-LEDs platform

UX4-LEDs LLO 150 Features

- Designed to process 150-mm sapphire wafers
- Enables reuse of sapphire substrates, thereby allowing a significant reduction of LED manufacturing cost

Note: The technologies covered by the following patents may be required when any user uses this system for production:

US7713840, US6559075, US6740604, US6974758, US7341925, US6420242, US6071795, and US6870125