First light on EBL2

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ICCC INTERNATIONAL CENTRE FOR CONTAMINATION CONTROL

EBL2

TNO is building EBL2 as a publicly accessible test facility for EUV lithography related development of photomasks, pellicles, optics, and other components requiring EUV exposure. EBL2 consists of a EUV Beam Line, a XPS system, and sample handling infrastructure. Recently we finished installation of the source, exposure chamber, handlers and XPS system. EBL2 accepts a wide range of sample sizes, including EUV masks with or without pellicles. All types of samples will be loaded using a standard dual pod interface. EUV masks returned from EBL2 will retain their NXE compatibility to facilitate wafer printing on scanners after exposure in EBL2. The Beam Line provides high intensity EUV irradiation from a Sn-fueled EUV source from Ushio. EUV intensity, spectrum, and repetition rate are all adjustable.

EBL2 will be accessible to third parties, delivering:

- **High EUV power and intensity**
- **Flexible sample size**
- **NXE compatibility**
- **Flexibility**
- **Parameter**
- **In-situ surface analysis**

Assembly of EBL2 started in June 2106 and First Light was achieved in December 2017.

EUV irradiation

A Sn-fueled Ushio LDP source is used to generate EUV. A two-stage grazing incidence collector system projects the EUV onto the mask location, as shown in Figure 2. The intermediate focus ensures separation of the source and sample gas environments.

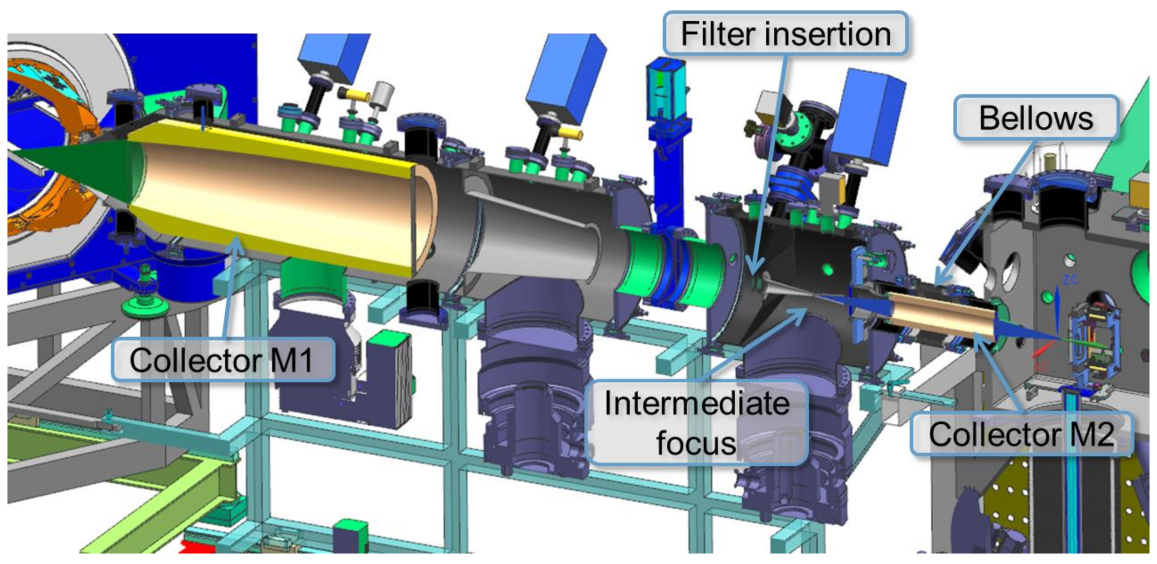

Figure 2: Collector module design overview

The spot size in focus is 0.8*1.2 mm, with peak intensity 1.3 W/mm^2 *in band*. Total EUV power is is around 10 W, while operating at 3 kHz. The EUV beam can be defocused by moving the Source and Collector Module away from the reticle. The maximum spot size attainable is over 30 mm, at which point the spot assumes a donut shape.

Light at unwanted wavelengths can be filtered using spectral purity filters (SPFs), which can be inserted between the collectors. The performance of one possible SPF design (50 nm Zr, 200 nm Si, 30 nm Mo) is shown in Figure 3. Light outside the 12.5-18.5 nm window is suppressed from 10% of total power to 1% of total power.

Figure 1: EBL2 after integration at TNO. From left to right: EUV source, collector, exposure chamber, handlers and XPS

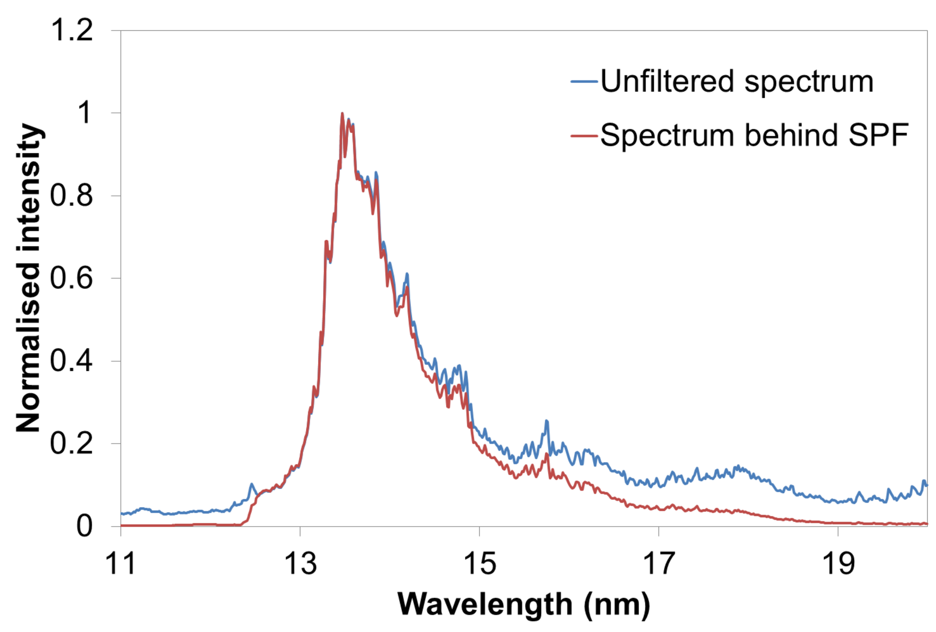

Figure 3: effect of an SPF.

Integration

After construction of the clean room assembly started in June 2016 with the exposure chamber and vacuum handler as central part of the system.

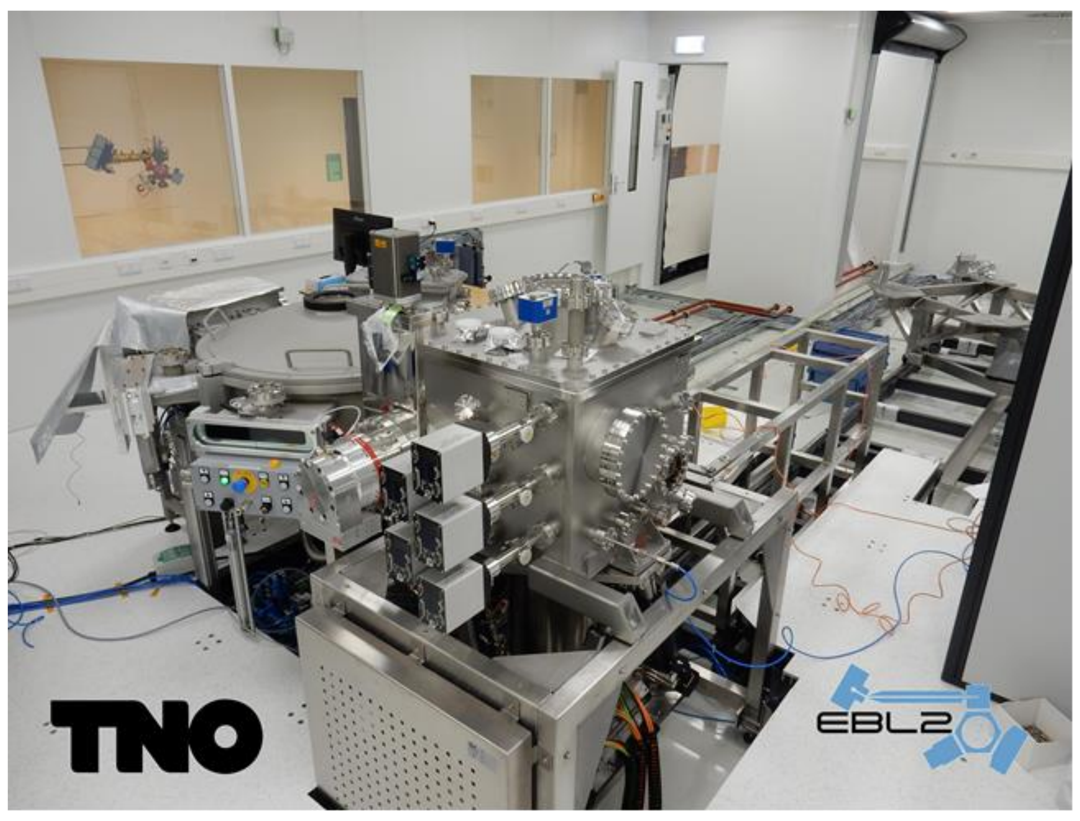

Figure 4: integration of exposure chamber and vacuum handler

In November 2017 XPS and the Ushio EUV source arrived in Delft and were assembled in the clean room.

First Light

In December 2016 the source was attached to the beamline and first runs were started. EBL2 currently holds a small collector and no full power is available on sample level

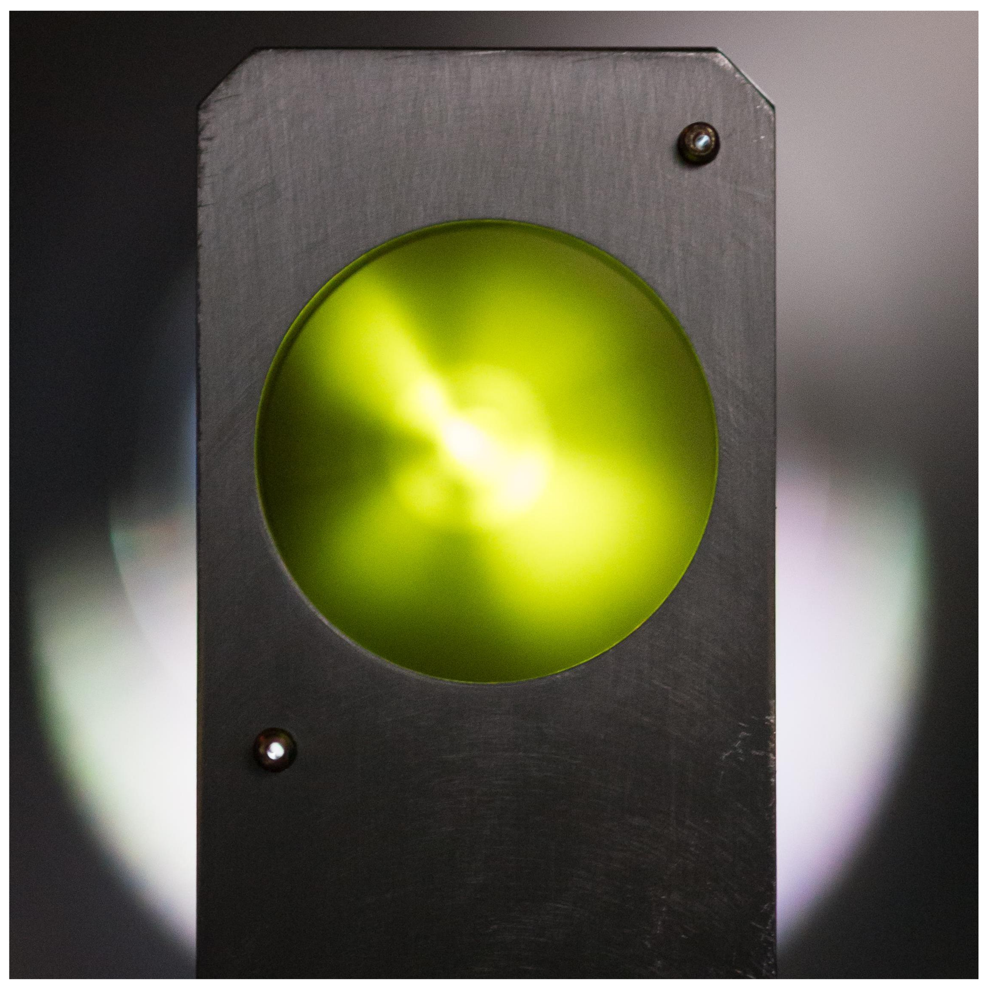

Figure 5: EUV spot of first light on scintillator.

The full collector will be installed in May 2017 and final commissioning of the system is expected to be finished at the end of second quarter of 2017. The XPS is commissioned and can accept samples using the automated handlers.

Acknowledgements

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EBL2

This work has been performed in the framework of the International Center for Contamination Control, established by TNO. Partners are welcome to join ICCC in the challenging development of dedicated contamination control solutions.