Realization of EBL2, an EUV exposure facility for EUV induced contamination research

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Introduction

TNO is realizing EBL2, a facility to investigate the effects of EUV radiation on surfaces to enable future EUV HVM production. At present the concept design is finalized and detailed design is almost complete and construction has started on both the cleanroom and the hardware.

The introduction of ever higher source powers in EUV systems causes increased risks for contamination and degradation of optics, reticles, pellicles, and sensors. Appropriate testing can help to inventory and mitigate these risks. Many of these tests cannot be done using the current EBL system. TNO is building EBL2 to address this issue.

Key parameters of EBL2 are summarized in table 1. The gas environment of the exposure chamber is capable of mimicking both scanner and source conditions.

Power	>1 W in 2% BW @ 13.5 nm ("IB") (~10 W 10-20 nm)
Power density	>1 W/mm² IB in focus
Spot size	1 – 30 mm diameter (power density scales)
Rep rate	1 Hz – 10 kHz (standard 3 kHz)
Sample size	Max 152x152x20 mm (EUV mask + pellicle possible)
Dose control	<20 % in free running experiment
Uninterrupted exposure time	>100 hours

Table1: EBL2 performance at a glance

EBL2

EBL2 is designed (Figure 1) with many improvements relative to the existing facility. It will deliver:

- **EUV power and intensity:** EBL2 will meet the intensity roadmap for all foreseen NXE scanners and LPP sources.
- **Increased sample size:** EBL2 will accept samples up to EUV mask size for both EUV exposure and XPS analysis.
- **NXE compatibility:** EBL2 will be placed in a conditioned area to maintain NXE compatibility of reticles received clean. Masks with pellicles are also accepted.
- **Increased flexibility:** Tunable EUV spot size & profile, more spectral filtering options, additional ports for EUVR or other analysis tools.
- **Predictability:** EBL2 will feature automated sample handling, a mature EUV source, improved dose control and measurement, and a wide range of gas environments up to 4 mbar, including controlled addition of trace contaminants.
- **Increased data:** EBL2 will have real-time in-situ imaging ellipsometry to monitor sample status, a real time RGA to monitor the gas environment, and EUV sensors that detect every pulse.
- **Surface analysis:** A modified Kratos XPS is capable of receiving full size sample from exposure without breaking vacuum

EBL2 will be accessible to third parties.

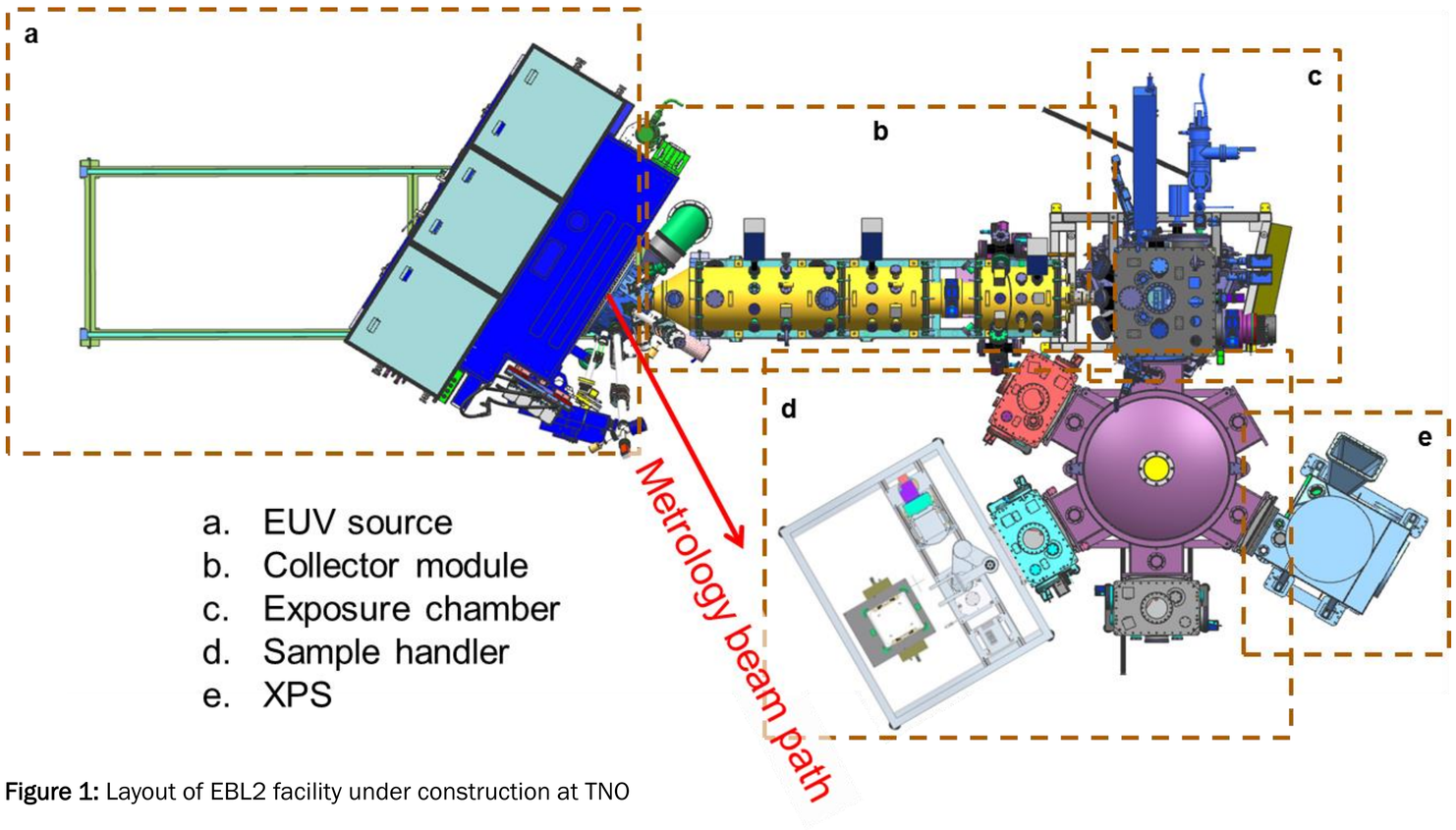

Figure 1: Layout of EBL2 facility under construction at TNO

Construction

Several modules (XPS, vacuum handler, atmospheric handler, source) and chambers are under construction and expected to arrive in the coming months. Integration of the system starts in august .

Figure 2: clean room area under construction

For the handlers the adjacent vacuum chambers are assembled and tested on vacuum performance before shipment to the supplier of the handler for final assembly.

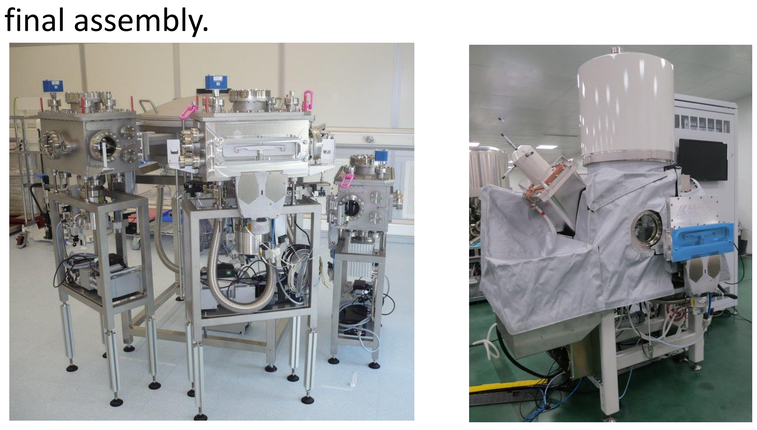

Figure 2: vacuum handler being build and XPS system being baked

The handling system is capable of handling both reticles on inner pod base plates and EBL2 sample holders. A transfer robot transfers the sample or reticle from an outer pod to the load lock, which is evacuated. A vacuum robot from ASYS then transfers the sample to any of the other modules. These include cleaning with hydrogen radicals, short term parking and long term vacuum storage, as well as the beam line and the XPS. A modified Kratos Axis Nova system will be able to address almost 100% of the reticle surface area.

Beam line

A Sn-fueled Ushio LDP source is used to generate EUV. A two-stage grazing incidence collector system projects the EUV onto the sample location. The intermediate focus of the two collector stages is used to separate the Ar environment of the EUV source from the Exposure Chamber keeping the Ar partial pressure below 1E-6 mbar. Gas composition will be controlled by a differentially pumped RGA system

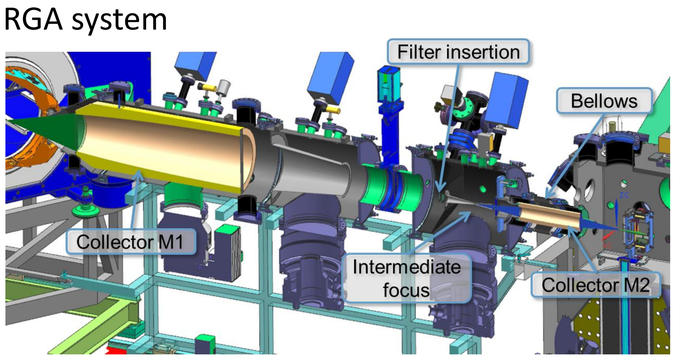

Figure 3: beam line with gracing incidence mirrors

Outlook

EBL2 will be a flexible and controlled EUV exposure and analysis facility, enabling experimentation, modelling and interpretation on many topics relevant to the EUV community. Its construction is well under way and first light is expected end of 2016. The facility will be open to users beginning of 2017.

In combination with our other facilities, ICCC can address optics life time, contamination control, material, pellicle and cleaning research questions.

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.