EBL2: EUV exposure and surface analysis system

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Introduction

At TNO, the EBL facility has been operated jointly by TNO and Carl Zeiss SMT since 2005. The facility shown in Figure 1 contains an EUV Beam Line, in which samples can be exposed to EUV irradiation in a controlled environment. Attached to beam line is an XPS system, which can be reached via an in-vacuum sample transfer system. This enables surface analysis of exposed samples without breaking vacuum. The compound instrument is used to develop and validate optics lifetime strategies for ASML EUV scanners[1].

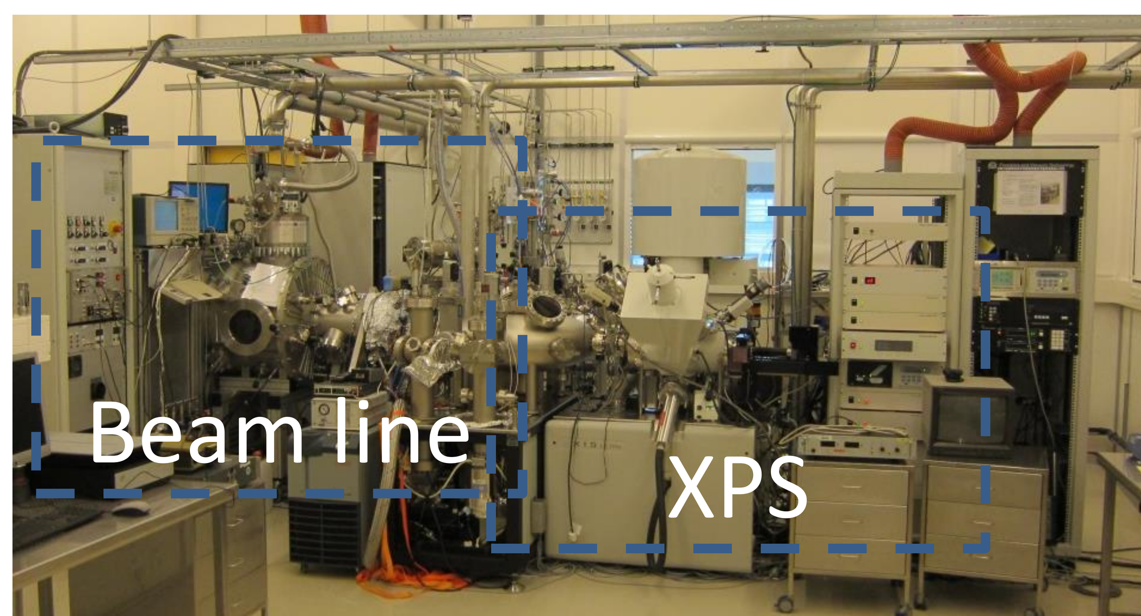

Figure 1: EBL facility at TNO

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.

EBL2

EBL2 is designed (Figure 2) with many improvements relative to the existing facility[2]. 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 ellipsometry to monitor sample status, a real time RGA to monitor the gas environment, and EUV sensors that detect every pulse.

EBL2 will be accessible to third parties.

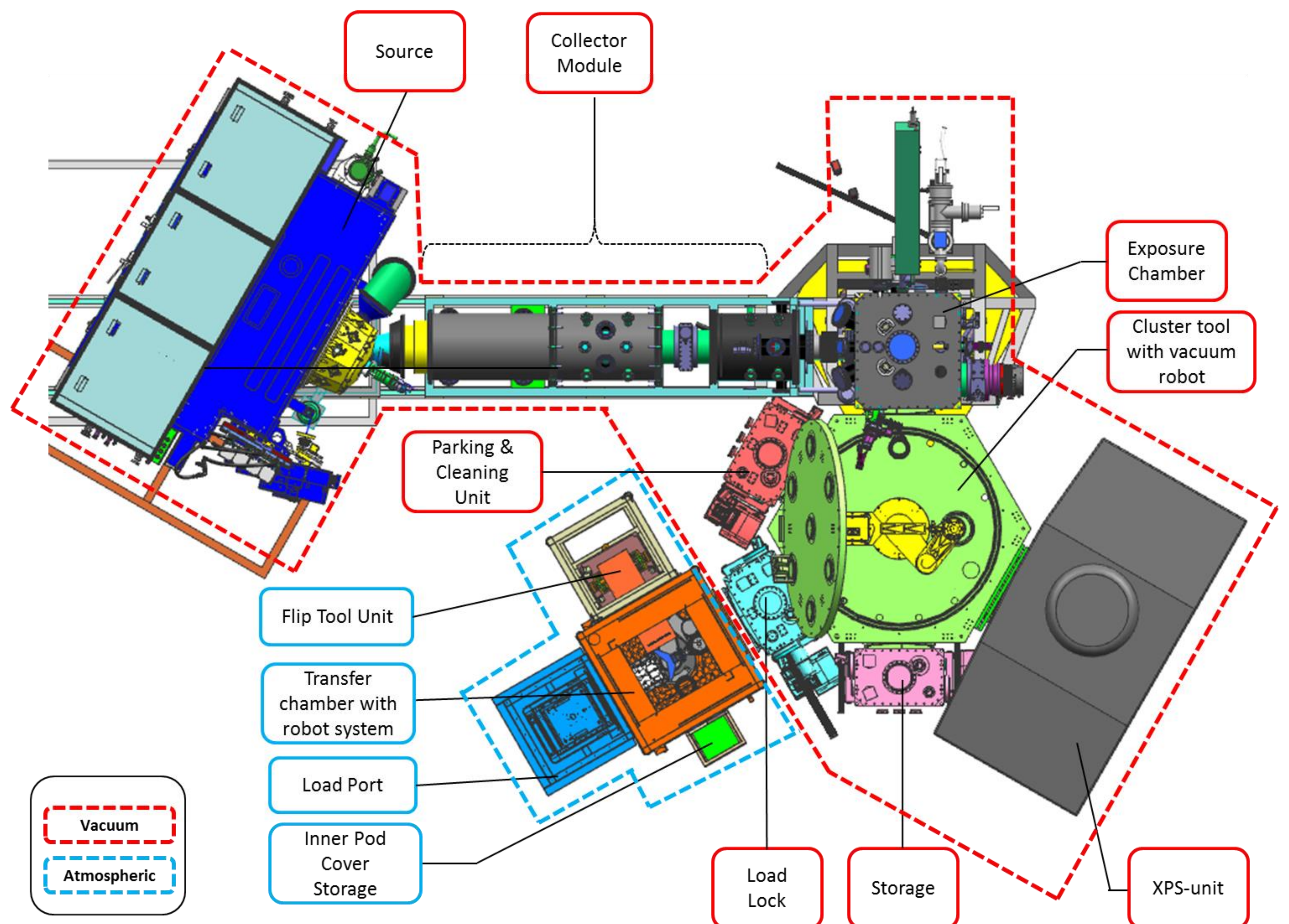

Figure 2: Layout of EBL2 facility under construction at TNO

Sample handling

EBL2 samples can be either EUV masks or smaller samples. EUV masks are accepted in a standard dual pod; a reticle flip tool is foreseen to ensure that the quality side can face upwards in the system. Smaller samples are mounted on a sample holder that shares SEMI standard reticle inner pod base plate interfaces (Figure 3).

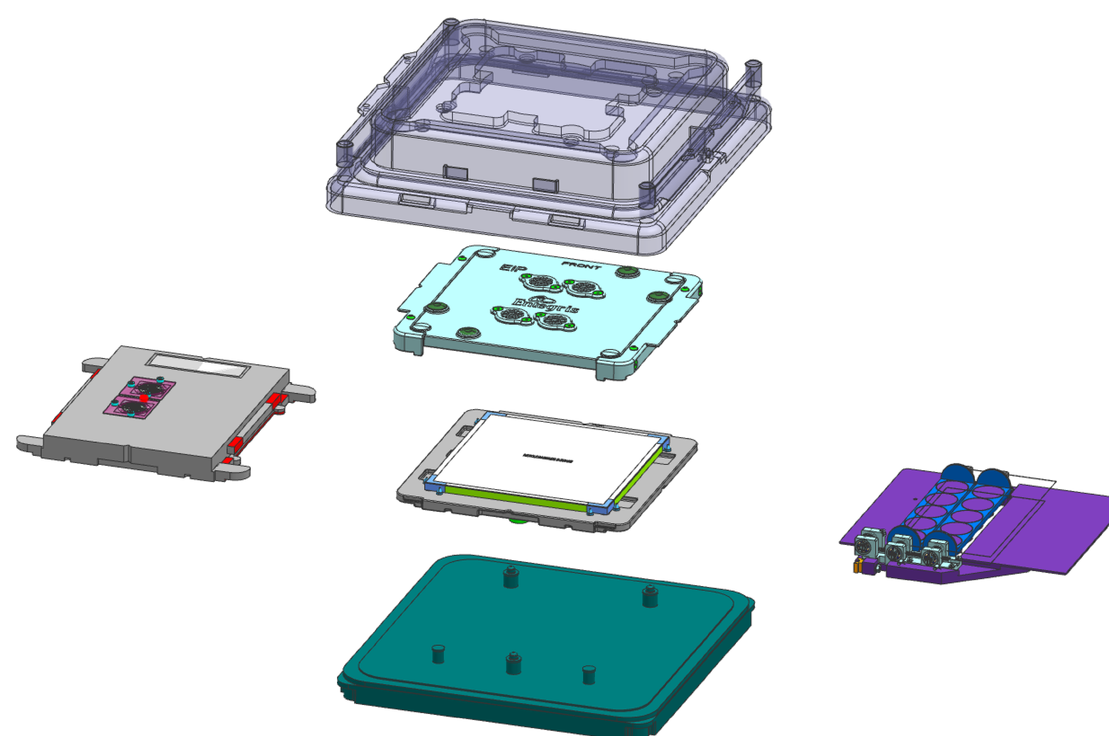

Figure 3: EBL2 sample holders and reticle in dual pod

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, which can maintain 1E-6 mbar during source operation.

For EUV exposure, a sample is loaded into the Exposure Chamber, rotated to face the EUV source, and mounted on an automated stage. The stage also contains EUV diagnostics and thermal control hardware. For reticles, only the mask itself is mounted and the base plate is stored in vacuum.

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 in the design phase, and the system is expected to be completed in late 2016.

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

1. N. Harned et al., EUVL symposium 2008, Lake Tahoe
2. E. te Sligte et al., Proc. of SPIE Vol. 9235 92351F

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.