

# NEXT GENERATION EUV RESIST OUTGASSING AND RETICLE CONTAMINATION TOOL MODEL NO. RER-300-PEX

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## 1. Introduction

We have successfully developed the first commercial EUV Resist Outgassing and Reticle Contamination Tool to evaluate the candidate EUV resists for the ADT where 13.5 nm light is collected and deliver 60 mW/cm<sup>2</sup> to a small spot on a 300mm diameter wafer coated with the resist. The wafer is loaded onto an x-y stage in the exposure chamber through a load lock. By translating the wafer the complete wafer can be exposed and the evolved gases measured with a residual gas analyzer (RGA). At the same time a part of the focused beam is split off and focused on a witness sample that can be removed to evaluate the degradation of the optics. Finally, the combination of the x-y wafer motion with a shutter to control exposure times allows the experimenter to obtain “dose snake” and thereby to measure the “dose-to-clear” of a candidate resist.

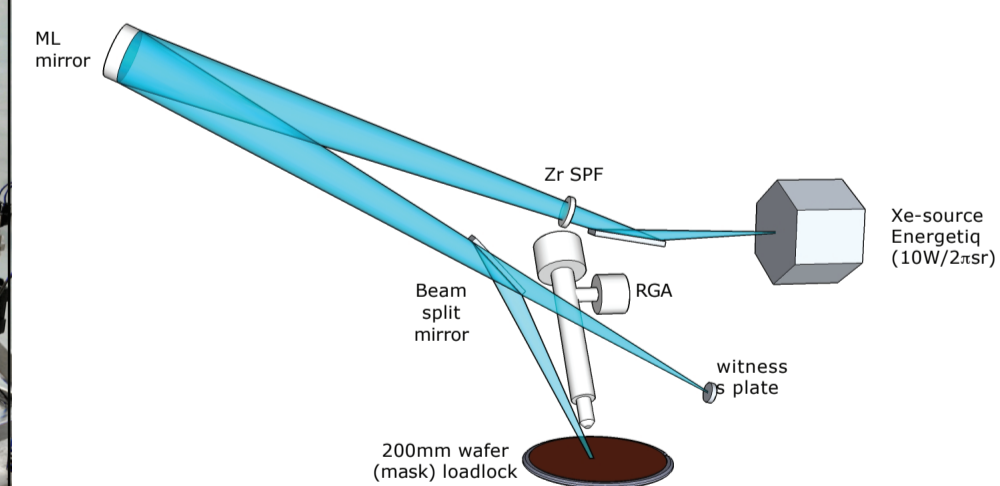
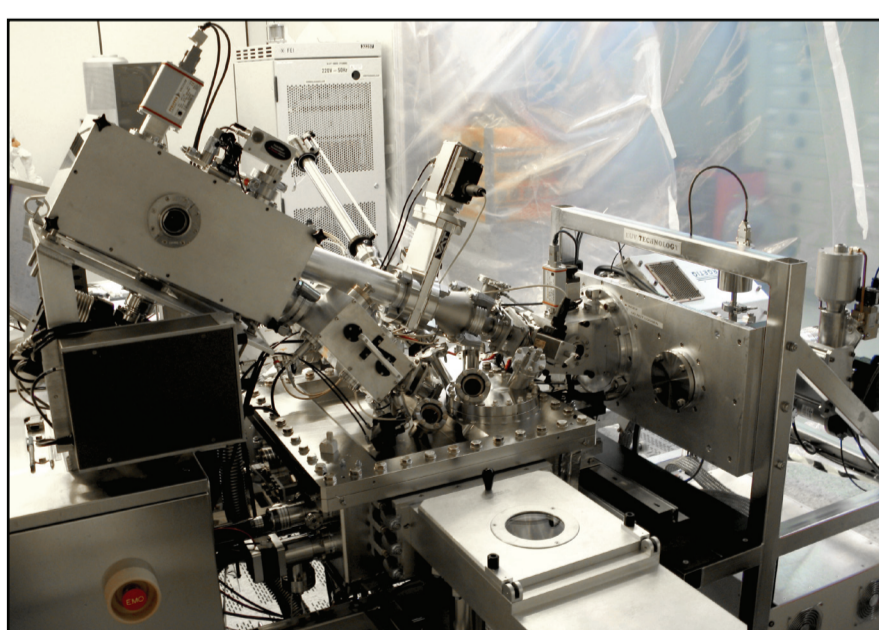
Based on our experience with first generation resist outgassing tool that has been fully operational for about 2 years with very good up time, we have developed a next generation resist outgassing tool for measuring the contamination of optics from resist outgassing by using 13.5 nm EUV photon exposure, or alternatively by using e-beam exposure, of resist coated 300 mm wafers and witness samples. This is carried out in an ultra-clean measuring chamber so as not to add background (non-resist related) contamination. This system can also be supplied initially with the e-beam exposure option and field upgrading to a photon exposure system by the addition of an Energetiq EQ-10 HP EUV source.

Next Generation EUV Resist Outgassing and Reticle Contamination Tool Model No. RER-300-PEX is designed to meet the stringent requirements for the NXE platform.

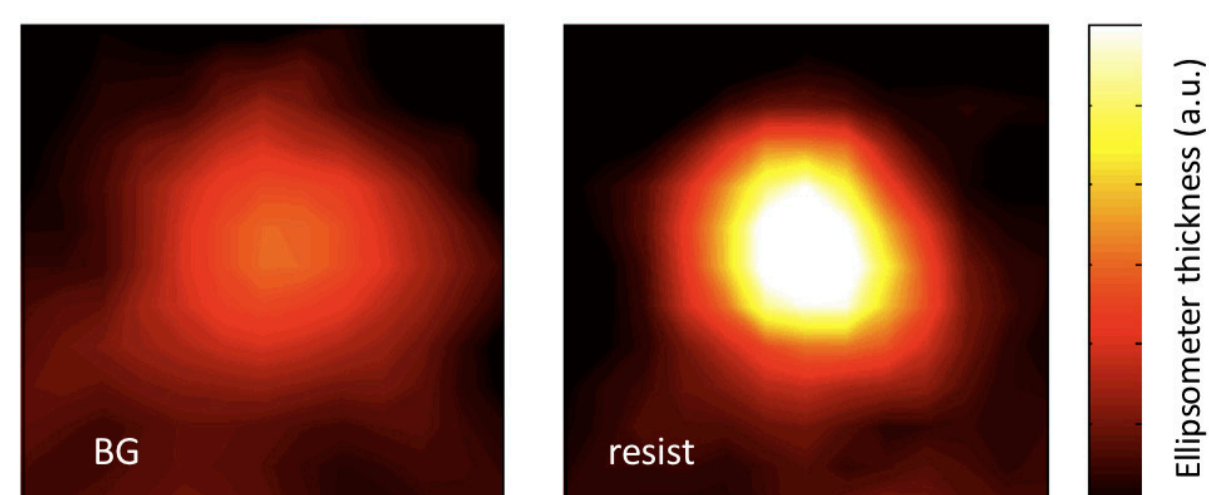
## 2. Specifications of the EUV Technology Model No. EUVRER134

- Uses Energetiq EQ-10 as the EUV source.
- Utilize a novel optical system to illuminate the resist-coated wafers or reticles for outgassing studies in the EUV region by witness plate testing and/or RGA.
- **FILTER SHIELD** to enhance Zr filter lifetime
- Power density at the resist - 5 mW/cm<sup>2</sup>.
- The power density at the witness plate - 80 mW/cm<sup>2</sup>.
- Ability to perform dose snakes.
- Dose uniformity better than 5 %.

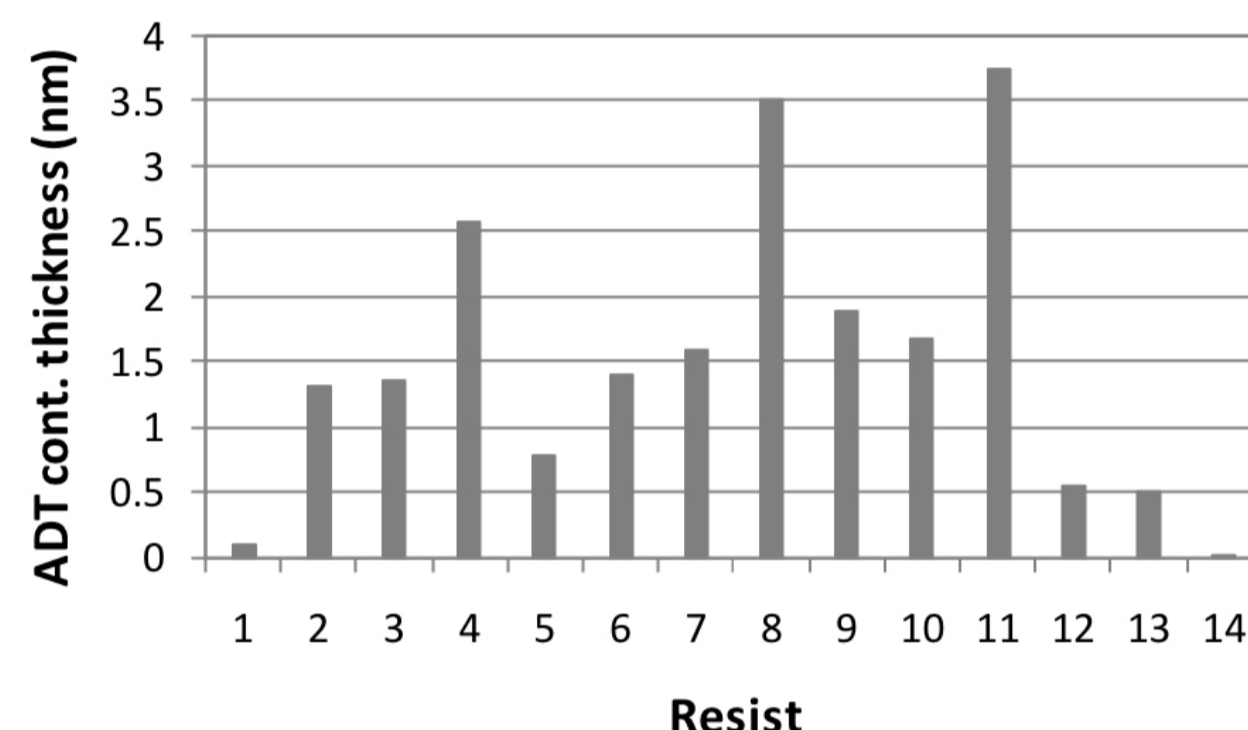
## 3. EUV Resist and Outgassing Prototype tool delivered to IMEC in October 2008 to meet the ADT guidelines



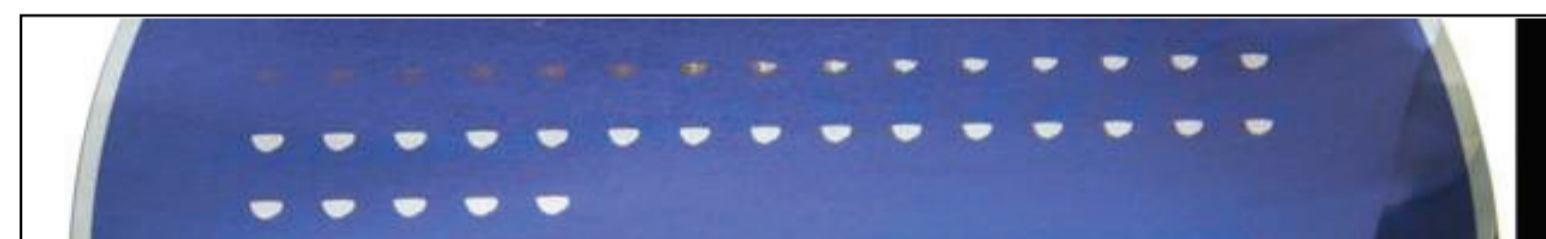
## 4. Example of WS test result using in-band EUV photon excitation as measured with ellipsometry



## 5. Overview of WS contamination test results obtained in last half year at IMEC as part of resist outgassing qualification towards ASML ADT (courtesy of Pollentier et al.)



## 6. Dose snake to determine Eo for a resist



Example of a variable exposure time “dose snake” on a resist coated wafer (post-development). Useful for determining dose-to-clear energy's.

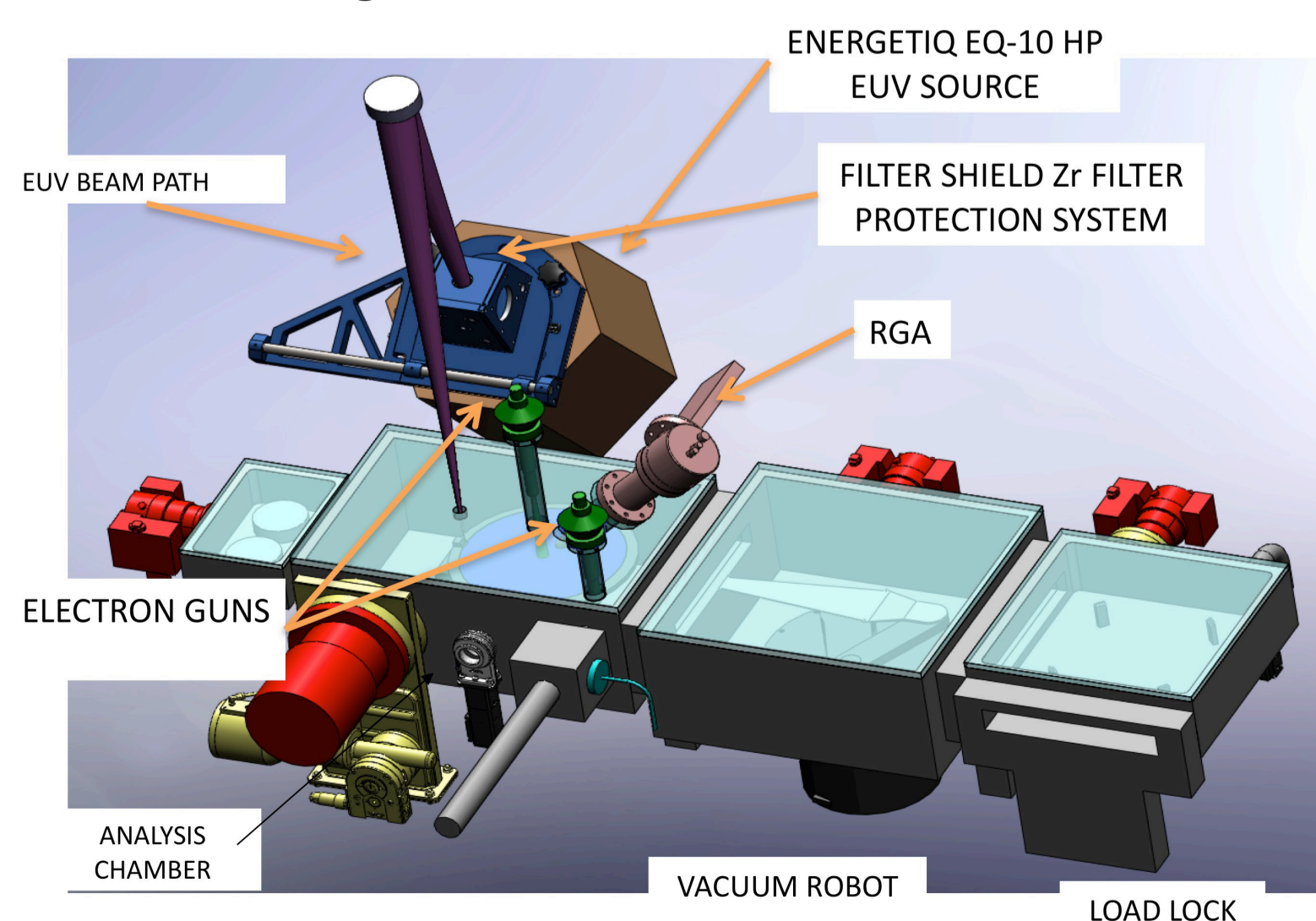
## 7. Design Philosophy of RER-300-PEX

- Based on our previous model of resist outgassing and contamination measuring tool delivered to IMEC in 2008 (Model No. EUV-RER1314; Patent Pending)
- Based on two ASML (confidential) guidelines for NXE scanners.
  - Photon based
  - E-gun based

## 8. Sources

- Model No. RER-300-PEX is equipped with:
  - In-band EUV photon excitation source
  - E-beam exposure capabilities to exposes resist coated wafers.
- System is designed in such a way that it can be ordered with one mode of operation and field upgraded to add the other option.

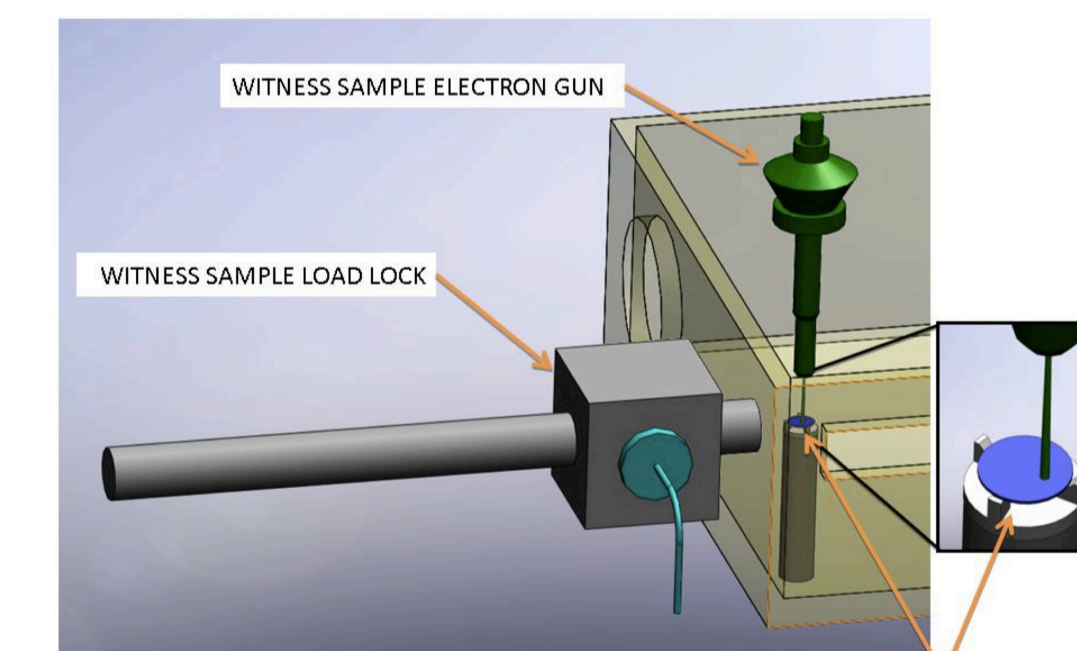
## 9. Schematic diagram of RER-300-PEX



## 10. Salient Features

- An Energetiq EQ-10-HP as the EUV source and/or an EFG-7F electron gun manufactured by Kimball Physics Inc., to expose the resist-coated wafer.
- A novel optical system to provide in-band spectrum of illumination of the resist-coated wafers when photon excitation is used, providing a power density at the wafer of 35 mW/cm<sup>2</sup>
- A filter shield to extend the lifetime of zirconium filters when photon excitation is used.
- An electron gun (wafer e-gun) capable of producing a beam current of 1 nA to 100 microA and energies of 50 eV to 2000 eV is used to expose resist-coated wafers when e-beam excitation is used. This wafer e-gun is positioned to illuminate the resist-coated wafer at 90 degrees to the wafer surface and to illuminate approximately 20 mm diameter spot on the wafer.
- A separate EFG-7F electron gun capable of producing a beam current of 1 nA to 100 μA at energies of 50 eV to 2000 eV to illuminate the witness sample at 90 degrees to its surface for cracking hydrocarbons during exposure to contamination with a spot size of 2-3 mm.
  - The illumination spot on the witness sample is positioned off-center to allow at least four exposures on one single witness sample and capability of measuring e-beam current with better than 15% accuracy.
- User-friendly LabView based software to control the tool and for data analysis.
- A calibrated leak valve, plasma cleaner and integrated heaters for baking the chamber
- Load lock equipped with a semi-automatic UHV 300mm transfer system that can be upgraded to accommodate a 300 mm FOUP
- Ability to perform dose snakes to determine the dose-to-clear for the resist used.
- A calibrated detector to measure the dose on the resist.
- Continuous monitoring of the source output EUV power using a high accuracy EUV detector when photon excitation is used and e-beam current from the wafer when electron excitation is used.
- Semi-automatic transfer system to transfer the witness sample to the main chamber and to unload it.
- High sensitive UHV RGA detection system, 1-256 amu, minimum detectable partial pressure of 5 x 10<sup>-13</sup> mbar and fast data acquisition rates to quantify resist out-gassing products and to check the cleanliness of the measurement chamber.

## 11. Witness Plate: 1" Ru coated Si or GaAs wafer or a ML coated (Ru cap) wafer



## 12. Highlights

- EUV Technology can provide customers with:
- Calibrated multilayer-coated witness samples
  - Collaborate with them to cross calibrate their witness sample contamination results, obtained by ellipsometry, to reflectivity losses using our in-house EUV Reflectometer.

## 13. Purchasing Information

Since EUV Technology's inception in 1997, we have been actively involved in the manufacturing of R&D tools for EUV Lithography and have provided many of the frontrunners in the semiconductor industry with EUV metrology tools.

U.S. Patent Pending for EUV Technology's EUV Resist Outgassing and Reticle Contamination Tool Model No. EUV-RER1314.

Purchasing inquiries can be made by contacting:

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