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FIRST-EVER MEASUREMENTS OF ION ENERGY DISTRIBUTION FUNCTIONS IN EUV INDUCED PLASMA

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Introduction

The EUV sources for ASML’s next-gen lithography tools allow us to investigate EUV induced plasmas, which up to recently, have been exclusively investigated by astronomers. EUV-induced plasmas are of significant importance with respect to the lifetime of components in EUV lithography tools. An important parameter is the ion energy distribution function (IEDF).

For the first time ion energy distribution functions (IEDFs) have been measured in an EUV induced plasma.

Surface interactions

IEDFs have been measured with the EQP in parallel and perpendicular configuration. In the perpendicular configuration EUV light hits the EQP sample plate. In the parallel configuration there are no surfaces exposed to EUV.

- Broad distribution
- Energy cut-off at 18 eV
- Bulk has low energy (<5 eV)
- Energy tail up to 22 eV
- \( H_3^+ \) density much lower than \( H_2^+ \)
- \( H_3^+ \) is converted to \( H_2^+ \) by collisions with background: \( H_3^+ + H_2 \rightarrow H + H_2^+ \)
- Secondary electrons reduce the \( T_s \) and \( V_{\text{atm}} \) and thereby the ion energy

Spectral effects

The spectrum produced by the EUV source also contains substantial amounts of lower energy Vacuum UV. A spectral filter, with a pass band of 10-20 nm can be used to reduce this out of band radiation.

- IEDFs of different species react similar to change in spectrum
- VUV increases the ions density due to larger ionization cross section
- Addition of VUV doesn’t change IEDF shape
- High spectral power creates a high energy shoulder

References


Experimental setup

The setup consists of an EUV source, collector vessel and measurement vessel. The EQP can be positioned in multiple configurations.

Outlook

- Verify numerical (PIC) models made by D. Astakhov (ISAN, Russia)
- Quantification of ion fluxes to assess EUVL tool lifetime
- Investigate scaling laws to deduce ion dynamics