

# Energy resolved mass spectrometry in EUV-induced plasmas

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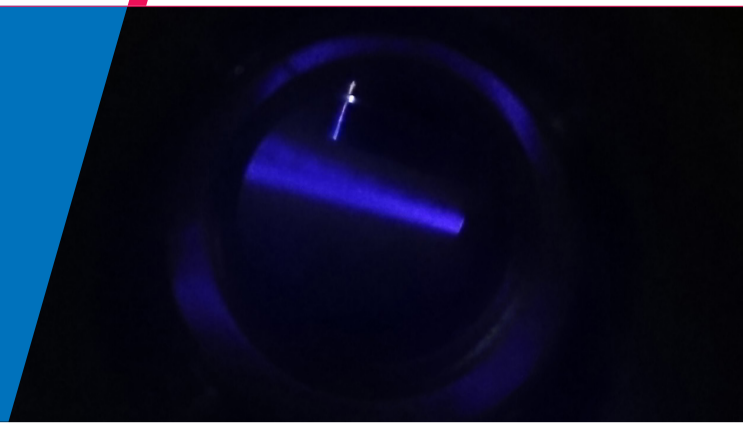
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# ENERGY RESOLVED MASS SPECTROMETRY IN EUV-INDUCED PLASMAS

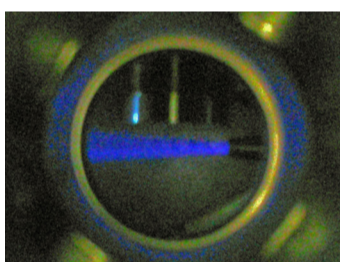
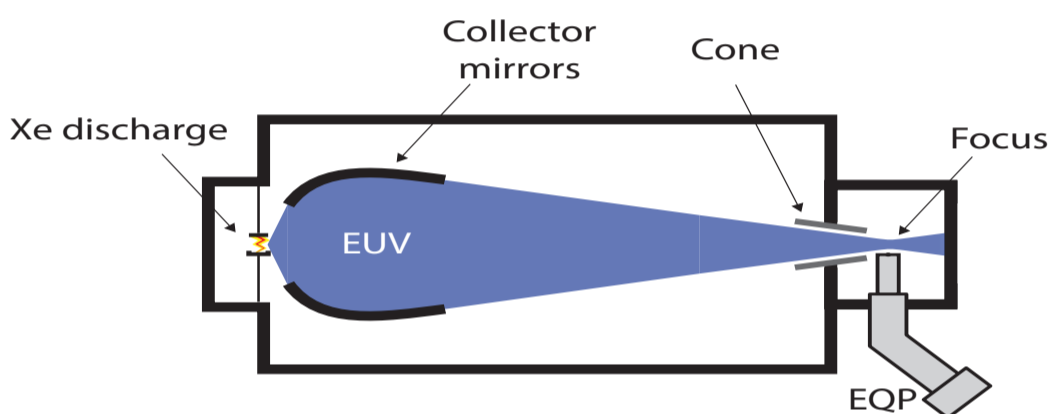
T.H.M. van de Ven, J. Beckers, E.A. Osorio, V.Y. Banine  
 Department of Applied Physics, Eindhoven University of Technology,  
 P.O. Box 513, 5600 MB Eindhoven, The Netherlands



In this research Extreme Ultraviolet (EUV) light with a wavelength of 13.5 nm is used to induce a plasma in low pressure background gas. Comprehending these plasmas is important for industrial applications such as EUV lithography. To improve the understanding of ions in the plasma an electrostatic quadrupole plasma analyser is used to investigate the plasma composition and the ion energies.

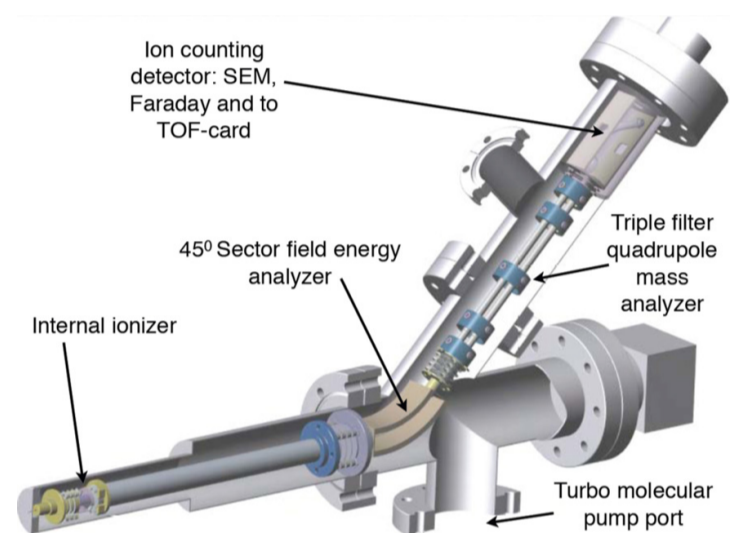
## PLASMA RESEARCH SETUP

- EUV generated by a pulsed Xe pinch discharge
- Collector mirrors focus EUV radiation
- Measurements done at Focus where the EUV intensity is highest



EUV pulse frequency: 500Hz  
 Pulse width: 100 ns  
 Electron density:  $10^{16} \text{ m}^{-3}$   
 Ionization degree: 0.01%

## ELECTROSTATIC QUADRUPOLE PLASMA ANALYZER (EQP)



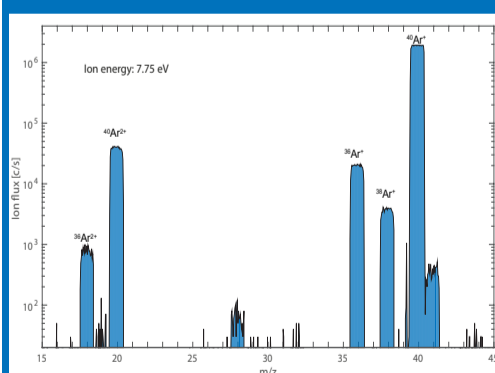
Hidden Analytic LTD., Warrington, England, <http://www.hiddenanalytical.com/>

- Simultaneous measurement of ion mass and energy
- Time resolved with resolution up to 50 ns
- Large dynamic range (1 -  $10^9 \text{ c/s}$ ) due to SEM and Faraday cup

## FIRST RESULTS

The first measurements show the potential of the EQP. Some leads for interesting experiments were found.

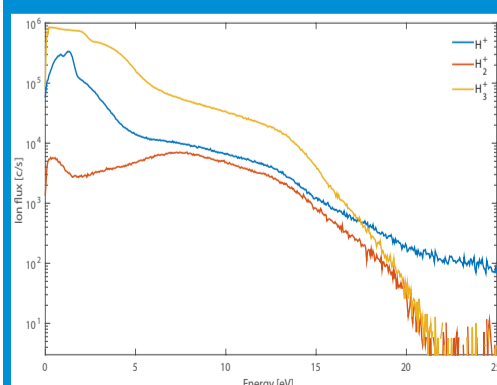
### ION MASS



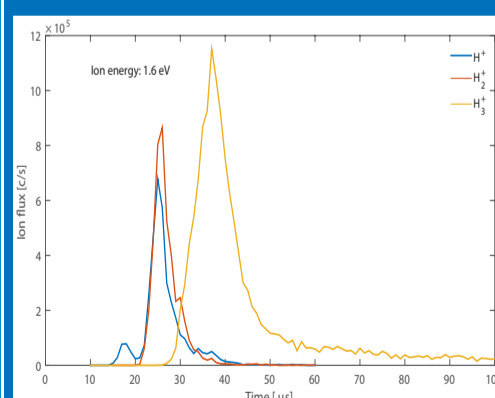
A mass scan of the ions in an argon plasma shows single and double charged ions. Also the argon isotopes are measured. The natural abundances are 0.34% for  $^{36}\text{Ar}$  and 0.063% for  $^{38}\text{Ar}$ .

### ION ENERGY

The ion flux in a hydrogen plasma is measured as function of energy for  $\text{H}^+$ ,  $\text{H}_2^+$ ,  $\text{H}_3^+$ . The measurements show a high energy tail of  $\text{H}^+$  which extends beyond the measurement range.



### TIME RESOLVED ION FLUX



The ion flux in a hydrogen plasma is measured as function of time.  $\text{H}_3^+$  reaches the detector at a later time than  $\text{H}^+$  and  $\text{H}_2^+$  which is (partly) explained by difference in flight time in the EQP due to the mass difference.

### TIME RESOLVED ION ENERGY

The development of the low energy part of the  $\text{Ar}^+$  energy distribution is measured as function of time with a resolution of 10  $\mu\text{s}$ . As the IEDF develops the peak of the low energy bump shifts to higher energies.

