

# Using a retarding field energy analyser for energy resolved time-of-flight mass spectrometry

Degree programme : Master of Science in Engineering

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To measure energy resolved mass spectra and calibrate the ion flux for each species, an energy resolved orthogonal time of flight mass spectrometer (TOF-MS) can be combined with a retarding field energy analyser (RFEA). The theoretical concept was proven to work and the performance was evaluated using HiPIMS and MW plasmas as ion sources.

The properties of contemporary materials are largely influenced by their production processes. The manufacturing conditions, particularly the kinetic energy of the species involved, strongly influence the internal structure and cohesion of these layers. Therefore, the controlled and well-defined manufacturing of modern materials necessitates a comprehensive understanding of the production conditions.

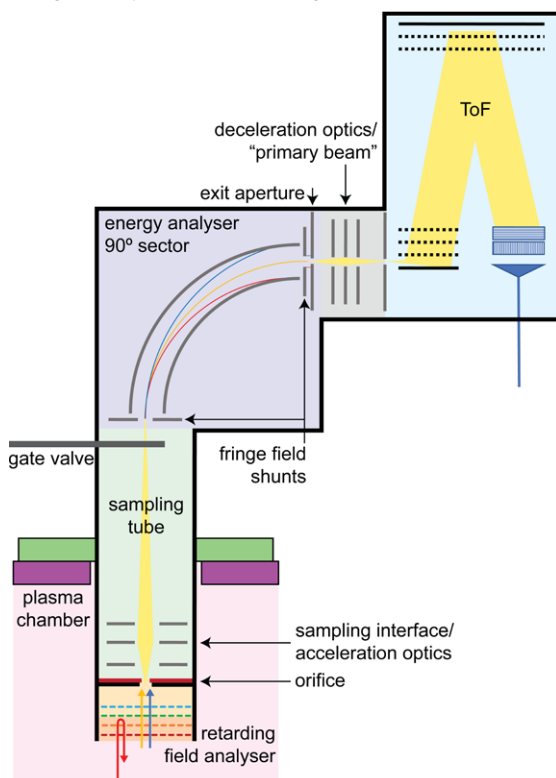
A TOF-MS allows the simultaneous recording of a mass spectrum over a large range at every extraction, which reduces measurement time compared to sequentially operating quadrupole or magnetic sector based mass spectrometers. Additionally this reveals unexpected species, produced during the process. For filtering ions by their kinetic energy different designs are possible one being an electric sector

analyser (ESA) which is an energetic band-pass filter. They can provide high energy resolution of up to 0.15V. Another solution are RFEAs which are energetic high-pass filters. Their compact design in addition to the possibility to measure an absolute ion current density which then can be used to calibrate the TOF-MS and calculate the ion current density per species, makes them an interesting option. An other advantage of the RFEA is that it can be put to complete transmission mode which allows to use the MS without energy resolution.

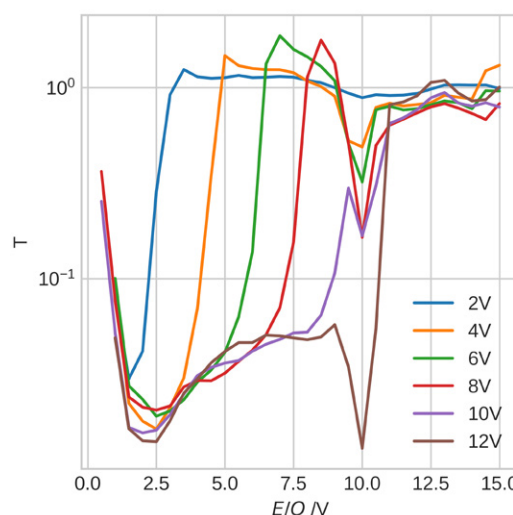
Commercially available RFEAs have a solid collector plate which doesn't allow ions to be passed to a mass spectrometer, for species identification. For this thesis such RFEAs were modified in different ways so that ions can be further analyzed with the TOF-MS after passing the RFEA. These RFEAs were then analyzed on the existing version of an energy resolved TOF-MS (E-TOFMS) [Fig 1]. The interest of this setup lies in the characterization of the energy dependent transmission of the RFEA [Fig 2] and in the application to calibrate the E-TOFMS for absolute species resolved ion current density measurements.



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Semitransparent retarding field energy analyser mounted on a energy resolved orthogonal time of flight mass spectrometer



Transmission T in function of the energy to charge ratio for ions showing the filtering behaviour of the RFEA