fibTOF: The combination of a FIB-SEM microscope with a TOF mass spectrometer for material characterization

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Keywords: fibTOF, FIB-SEM, SIMS, thin film, material characterization

Modern FIB-SEM dual beam microscopes are useful tools for surface characterization and structuring on the micro- and nanoscale. Surface characterization with the electron beam and appropriate accessory detectors allows e.g. local topography, crystallinity (EBSD), and composition (EDX) of a surface can be determined.
A measurement of the local surface composition can also be done by using a mass spectrometer to detect ions sputtered by the FIB beam. This secondary ion mass spectrometry (SIMS) approach can achieve higher spatial resolutions than electron beam techniques (since the primary ions are not scattered so much within the sample) and is particularly useful when imaging light metals or halogens. The mass spectrometer developed by TOFWERK uses the time of flight principle to identify the mass of sputtered secondary ions (Figure 1). The incoming ions are extracted in a direction orthogonal to the initial flight path. This allows the use of a continuous FIB beam to sputter the surface which has advantages for the mass resolving power (and requires no modification to the microscope). The synchronization of the ion extraction with the scanning of the high brightness FIB beam leads to the elemental detection and imaging with a lateral resolution <50 nm and depth resolution <10 nm (depending on the FIB beam settings). The high sensitivity allows elemental concentrations at optimal analytical conditions down to a few ppm to be imaged.
In this presentation we will explain the design and the working principle of the fibTOF mass analyser in combination with a FIBSEM microscope. The best analytical conditions for chemical mapping with either high lateral or depth resolution will be described. The ability of the instrument to measure thin layers and to detect buried interfaces will be demonstrated using the example of a multilayer AlGaAS/GaAs structure. The ability to detect all elements simultaneously, allowing unlimited post-acquisition data analysis will also be demonstrated for a sample containing light elements prominent in lithium containing batteries.

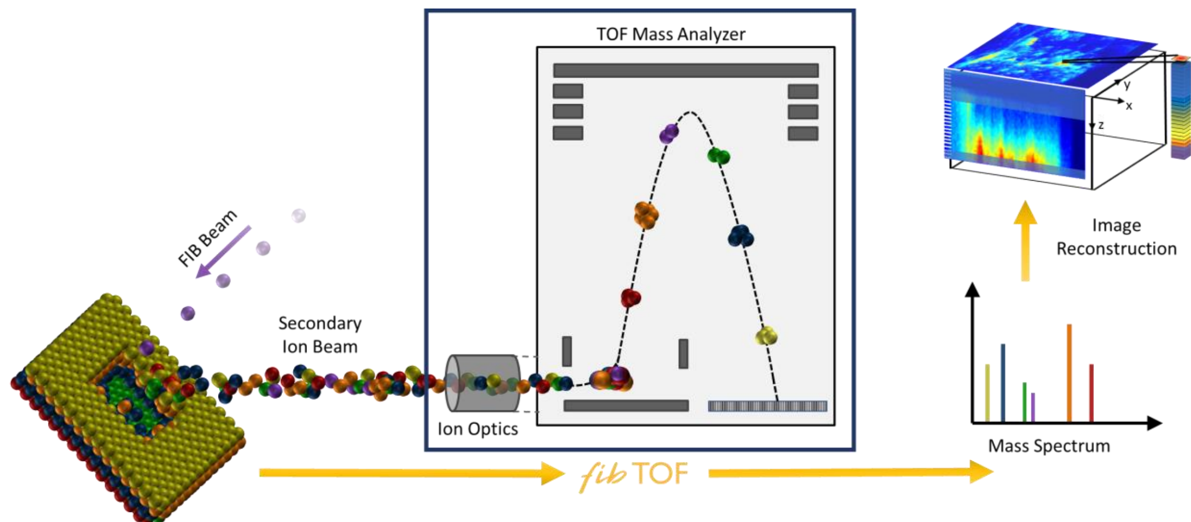

Figure 1: Schematic of FIB-SIMS operation using Tofwerk's fibTOF instrument