SNMS/SIMS

With decreasing dimensions and increasing complexity of thin film and multilayer structures, the traditional techniques for the chemical and physical characterization of materials need to be replaced by the modern techniques of physics. The quantitative composition of these structures and surface layers down to trace elements is often of crucial importance for the quality of products. Detailed knowledge here means a decisive advantage over competitors.

Secondary Neutral Mass Spectrometry using electron gas post-ionization is ideally suited to quantitative elemental and depth profiling analysis of any material. Minimal matrix effects and no influence due to preferential sputtering allow very accurate material analysis. Since the sample current is highly uniform over the entire analysed area and the sputtering energies are low (a few 100 eV), high depth resolution can be achieved by SNMS. Mass analysis is performed by a quadrupole type mass spectrometer up to 340 amu.

A Secondary Neutral Mass Spectrometer (SNMS) type INA-X (SPECS GmbH, Berlin) supplemented with Secondary Ion Mass Spectrometer (SIMS) is in operation in our laboratory. The SNMS/SIMS machine is suitable for the following application:

- **analysis of conducting and insulating material**
- **depth profiling for scientific and industrial applications**
- **impurity and contamination analysis in quality control**
- **analysis of buried interfaces**
- **environmental analysis**

FEATURES:

* Detection limit down to 1ppm
* Simple quantification of sample composition
* High depth resolution in the nm regime (≤ 2 nm)
* Analysis of conducting and insulating materials

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Department of Solid State Physics
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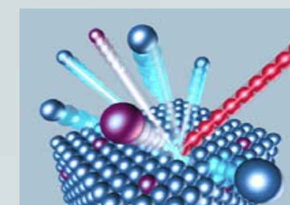
SNMS/SIMS

depth profiling and quantitative elemental analysis of materials at nanoscale

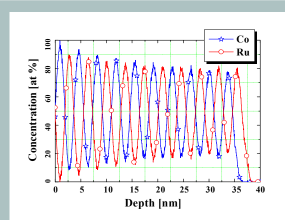


http://www.atomki.hu/SNMS

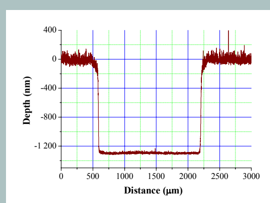
ANALYSIS OF NANOSTRUCTURES BY SNMS

Multilayer Analysis

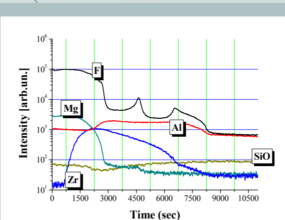
High depth resolution is achieved by using low energy ion bombardment (~100 eV). Due to the high lateral homogeneity of ion bombardment, sputter craters with an extremely flat bottom are produced.



Si/Co multilayer on c-Si substrate with 3.6 nm double layer thickness. Total thickness: 35 nm.



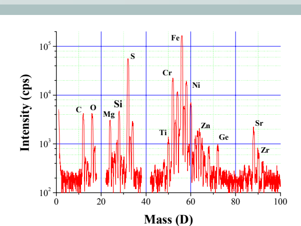
Sputter crater measured by AMBIOS XP-I profiler



Depth profile of antireflex coatings on optical glass

Composition Analysis

The application of SNMS on composition analysis provides a rapid quantitative method for surface and bulk characterization of materials.



Mass spectrum of an archeological sample

Sensitive elemental analysis completed with a quantitative chemical analysis is indispensable for preparing good quality thin layers. Detailed knowledge of the interfaces within a layered structure or between a thin layer and a substrate can play a decisive role in ensuring the desired functional properties of a thin layer structure. Depth profiling is one of the most powerful method of determining the depth distribution of atomic composition. It can be performed by ion sputtering which is a destructive method, where particles are removed from the surface.

A Secondary Neutral Mass Spectrometer (SNMS) supplemented with a Secondary Ion Mass Spectrometer (SIMS) is an ideal piece of equipment for performing quantitative depth profile analysis of thin films. While SNMS can be used to produce high depth resolution, SIMS is suitable for producing high lateral resolution.

Plasma/Sputter Parameters:

Type: ECWR Plasma, 27 MHz
Pressure: $5\cdot10^{-5}$ - $5\cdot10^{-3}$ mbar
Ion Energy: 100 eV - 2 keV
Used gas: typically noble gases (Ar, Ne, Kr, Xe)
Sputter Modes: Direct Bombardment Mode (DBM) and High Frequency Mode (HFM)
Typical Sputter Rates: 1 nm/s @ 130 eV Ion Energy, 10 nm/s @ 1keV Ion Energy
Sputter Diameter: 0.3 - 14 mm
Post Ionisation Efficiency: 1%

Detection:

Ion Optics: 45° spherical sector analyser
Mass Spectrometer: Balzers QMG 422, differentially pumped
Mass Range: 0-340 amu
Detector: Secondary Electron Multiplier (SEM), Single Ion Counting
Detection angle: 30°
Detection Limit: 1 ppm
Detection Sensitivity: 5 - 10 cps/ppm
Depth Resolution: ≤ 2 nm
Background Level: ≤ 5 cps
Operation Pressure: $5\cdot10^{-5}$ - $5\cdot10^{-3}$ mbar

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