

Secondary Ion Mass Spectrometry characterization of thin films with nanometer and subnanometer depth resolution

Secondary Ion Mass Spectrometry (SIMS) is a very precise surface sensitive analytical technique. A sample is bombarded with a primary ion beam which leads to the sputtering of the matter from its surface. A small part of the sputtered particles are charged (secondary ions). They are collected and undergo spectral analysis which provides information about their mass to charge ratio. A proper interpretation allows to determine the elemental and/or isotopic composition of the sample. Subsequent layers of the sample are removed during the analysis and thus it is possible to determine how the composition changes as a function of depth, creating so called depth profiles. The lateral analysis of the signal allows to create 3D images and cross-section views of the sample.

The aim of the project is to characterize materials with nanometer and subnanometer depth resolution with the SIMS technique. Such a depth resolution is required for analysis of ultra-thin films, especially 2D materials which are only a few atoms thick. Unfortunately, most SIMS spectrometers do not reach such a good resolution and thus the results are blurred and a proper interpretation of various physical and chemical phenomena at the nanoscale is not possible. To perform such measurements it is essential to establish dedicated measurement procedures which are targeted at one specific type of material. In this way the sensitivity of the spectrometer can be increased and, as a consequence, a desired depth resolution can be reached. It is, however, time-consuming because it requires an individual approach for every type of material - it is common that additional optimization is required even for similar samples. Establishing a large database of dedicated measurement procedures should significantly decrease the preparation time for an unknown material because an adaptation of an existing procedure is much faster than establishing it from scratch. The ultimate goal of the projects is therefore to make the SIMS technique capable of characterization of ultra-thin materials.