Comparison of grazing incidence X-ray fluorescence and X-ray reflectivity data obtained at the XRF beamline of the Elettra Sincrotrone Trieste and an optimized lab spectrometer

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Grazing Incidence XRF (GIXRF) analysis is a sensitive technique able to provide information about the elemental composition, concentration profile and thickness of near surface layers. The technique is typically used for the characterization of impurities or thin film structures in or on semiconductor surfaces. As the penetration depth of the incident X-ray beam in the total-reflection regime is very small, i.e. in the order of only a few nanometers, the XRF spectra represent the elemental concentrations of this near surface region. Varying the angle of incidence in the grazing incident regime and collecting XRF spectra at several angle positions results in angle dependent intensity curves for each element, which contain information on depth distribution and mass density of the elements in the sample. By fitting calculated curves to these experimental data, density and thickness of layers or depth distributions of implanted atoms can be determined in the near surface region. Above the surface of the reflector an X-ray Standing Wave (XSW) is formed due to the interference between incident and reflected beam. This XSW field with its angle dependent distance in the nanometer range between nodes and antinodes can be used for the characterization of nanostructures on the surface.

X-ray reflectometry (XRR) is an established technique for the characterization of single- and multilayered thin film structures with layer thicknesses in the nanometer range. XRR spectra are acquired by varying the incident angle in the grazing incidence regime while measuring the intensity of the specular reflected x-ray beam. The shape of the resulting angle-dependent curve is correlated to changes of the electron density in the sample.

The recently commissioned multipurpose X-ray spectrometry end-station provided by International Atomic Energy Agency (IAEA)[1] located at the new X-Ray Fluorescence beamline developed by Elettra Sincrotrone Trieste[2] allows for combined GIXRF and XRR measurements. In order to evaluate the capabilities of this new setup, several samples have been successively measured at the lab spectrometer available at the Atominstitut in Vienna, which has already been used successfully on a wide range of samples[3][4], and at the IAEA spectrometer. The measured samples include Ti and Au layers with thicknesses in the nanometer range on Silicon substrate as well as nanoparticles with an approximate size of 10 nanometers. The measurements were performed at 8.04 keV corresponding to Cu-Kα, in order to facilitate the comparison between synchrotron and laboratory.

A comparison of the performance of the spectrometers with respect to GIXRF and XRR measurements will be presented. Moreover, simulations and evaluations, which were performed using JGIXA, will be shown.