TXRF/GIXRF high precision laboratory setup with high flux monochromatic source

Claudia G. Fatuzzo[1,2]*, Philipp Hönicke[3], Claudia Caliri[1,2], Roberta Ricciari[4], Daniele Pagano[4], Andreas G. Karydas[1,5], Patrizia Vasquez[4] and Francesco Paolo Romano[1]

*claudia.fatuzzo@ispc.cnr.it

(1) Istituto di Scienze per il Patrimonio Culturale – CNR, via Biblioteca 4, 95125 Catania, Italy
(2) Laboratori Nazionali del Sud – INFN, via Santa Sofia 62, 95123 Catania, Italy
(3) Physikalisch-Technische Bundesanstalt (PTB), Abbestr. 2-12, 10587 Berlin, Germany
(4) STmicroelectronics Catania, Str. Primosole 50, 95121 Catania, Italy
(5) Institute of Nuclear and Particle Physics, NCSR "Demokritos", 153 10 Athens, Greece

The technological development of compact high flux X-ray tubes on one hand and high efficiency detectors on the other allows the implementation of high precision XRF instrumentation within in-house laboratories, in this specific case also taking advantage of the integration of Montel optics that produce a highly monochromatic parallel beam (at the energy of the silver Ka). Combining these instruments with high precision rotational and translational stages, the result is a versatile set-up that can smoothly and easily perform experiments in total reflection geometry (TXRF), scan of the incidence angle (GIXRF), 'classic' XRF, all the way down to grazing emission experiments, with precision in the order of 10^{-3} deg.

The control over the incidence angle gives access to the depth profile of surface depositions or layers (since the x-ray penetration depth changes with the angle of incidence), while measurements in total reflection conditions strongly enhance the signal from the surface (since the X-rays penetrate only for a few nanometers within the sample before being totally reflected – thus producing a standing wave confined along the sample surface) thus dramatically improving detection limits. A detailed numerical model was developed to describe the dependence of the effective solid angle upon the detector's collimation and distance from the sample (that can be varied between few mm to few cm) and the set-up has been used to determine the depth profile of a well characterized sample consisting in a Si substrate with a Ni surface deposition [1] to validate the model. Investigations of SiC substrates with homogeneous and inhomogeneous surface contaminations have been performed with the goal of optimizing the instrument for industrial applications.

[1] Philipp Hönicke, Ulrich Waldschläger, Thomas Wiesner, Markus Krämer and Burkhard Beckhoff, 2020, Spectrochimica Acta Part B: Atomic Spectroscopy **174**, 106009.