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Time-of-flight methods in ion beam analysis

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Ion beams with MeV energies offer great possibilities for the characterization and investigation of different types of materials, from inorganic thin films to tissue sections. Using different primary ions and detectors, elemental or molecular composition, thickness, and depth profiles can be determined.

Most of the ion beam techniques are based on the interaction of light ions, such as protons or alphas, with the material. However, some information can be deduced only by analyzing secondary particles or molecules, in which case heavy incident ions have to be used. Two methods that utilize heavy ion beams in the MeV energy range for the production of secondary particles are Time-of-flight Elastic Recoil Detection Analysis (TOF-ERDA) and Time-of-flight Secondary Ion Mass Spectrometry (MeV TOF-SIMS). For both techniques, the time-of-flight of secondary particles or molecular ions is measured to determine their mass.

At the Ruđer Bošković Institute accelerator facility, both TOF-ERDA and MeV TOF-SIMS setups are built at the 0-degree beam line allowing the use of high-energy heavy ions. Using TOF-ERDA setup depth profiles of different elements/isotopes within thin films, including hydrogen and its isotopes, are routinely measured with 1 nm depth resolution and high detection efficiency. In the last few years, MeV TOF-SIMS setup with collimated beam and reflectron TOF analyzer was developed in the extension of TOF-ERDA setup for the analysis of organic samples (imaging of animal tissue sections, fingermarks, paintings, etc.).

In this talk, setups and examples of materials analysis will be presented, as well as challenges associated with the practical implementation, especially with the TOF measurement on the MeV TOF-SIMS setup.

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