Upgrade of the new ToF – ERDA experimental setup at N.C.S.R. "Demokritos"

A.Ziagkova[1,2], A. Lagoyannis[1], M. Axiotis[1], E. Makarona[3], M. Kokkoris[2], E. Taimpiri[1,2]

[1]*Tandem Accelerator Laboratory, Institute of Nuclear and Particle Physics, N.C.S.R "Demokritos", Aghia Paraskevi, 15310 Athens, Greece*

[2]*Department of Physics, National Technical University of Athens, Zografou campus, 15780 Athens, Greece*

[3]*Institute of Nanoscience and Nanotechnology, NCSR "Demokritos", Aghia Paraskevi, 15310 Athens, Greece*

Presenting author email: ziagkova_an@mail.ntua.gr

Ion Beam Analysis (IBA) is a family of modern analytical techniques which are widely used for the analysis of different samples. Among them, the most promising and suitable one for surface analysis and characterization of thin foils is the Time of Flight – Elastic Recoil Detection Analysis (ToF-ERDA). The new ToF–ERDA spectrometer in the Tandem Laboratory of N.C.S.R. "Demokritos" consists of two timing (MPC) detectors for the determination of the time of flight of the recoiled particles and one Silicon Surface Barrier (SSB) detector for the recording of the total amount of their deposited energy. Thus, the *in-coincidence* data processing leads to a high accuracy mass separation and depth resolution regarding both light and heavier elements present in a sample.

The spectrometer detection efficiency varies with respect to the ion type and energy. This effect is more intense for light elements and occurs due to the different number of the emitted secondary electrons while the ions pass through the MCP foils[1]. In order to improve the detection efficiency of the setup, different materials such as carbon foils coated with LiF or Silicon Nitride thin films are used for the triggering of the timing detectors aiming at replacing the standard carbon foils. The results and the comparison between the different cases will be shown.

ToF-ERDA measurements of Li-doped ZnO targets, that are used as semiconductors, were conducted in order to reveal the presence and the concentration of lithium in the samples. The detection of lithium, as well as of several light elements is not easily directly obtained with other IBA techniques. The corresponding results reveal the high sensitivity and the low detection limit that can be achieved by the ToF-ERDA technique even for low mass elements, such as hydrogen present in a sample.

For the future upgrade of the setup, a new Gas Ionisation Detector (GID) will be built with the aim of replacing the SSB energy detector. GID detection chambers are more resistant to radiation damage and suitable for the specific application[2][3]. The first simulated results of the new detector will be presented.

References

[1] Y. Zhang *et al.*, "Detection efficiency of time-of-flight energy elastic recoil detection analysis systems," *Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater. Atoms*, vol. 149, no. 4, pp. 477–489, Mar. 1999, doi: 10.1016/S0168-583X(98)00963-X.

[2] Z. Siketić, N. Skukan, and I. Bogdanović Radović, "A gas ionisation detector in the axial (Bragg) geometry used for the time-of-flight elastic recoil detection analysis," *Rev. Sci. Instrum.*, vol. 86, no. 8, Aug. 2015, doi: 10.1063/1.4927605/357185.

[3] J. Julin, M. Laitinen, and T. Sajavaara, "Time-of-flight ERD with a 200 mm2 Si3N4 window gas ionization chamber energy detector," *Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater. Atoms*, vol. 332, pp. 271–274, Aug. 2014, doi: 10.1016/J.NIMB.2014.02.076.