The First Year of Analyzes with the New ToF-ERDA Installation at STU in Trnava Laboratory*

Jozef Dobrovodský †, Pavol Noga, Dušan Vaňa, Robert Riedlmajer

[1] *Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Advanced Technologies Research Institute, Jana Bottu 25, 917 24, Trnava, Slovakia*

The ion beam laboratory of STU Bratislava, located in Trnava, provides high-energy ion implantation/modification of materials and ion beam analysis based on RBS, NRA, PIXE, ERDA (with absorber) methods, especially for materials research. The laboratory, equipped with a 6 MV tandem ion accelerator [1] was supplemented a year ago with a new Time-of-Flight Elastic Recoil Detection Analysis (ToF-ERDA) setup. The complete delivered ToF-ERDA installation was the University of Jyväskylä, Finland design [2]. In addition to two timing gates, the system contains a gas ionization chamber (GIC) - as an energy detector.

Typically, the ^{127}I and ^{197}Au primary ion beams and energies in the range of 40 to 60 MeV were used for ToF-ERDA analysis. An overview and experience from ToF-ERDA analyzes of elemental depth concentration profiles of samples, performed during the first year of system operation, will be presented. The main parameters of the analysis achieved, such as sensitivity, depth resolution, depth of analysis and also the possible influence of the analyzing beam on the change of sample composition during the analysis, will be discussed.

References

[1] P. Noga *et al.* Nucl. Instr. Meth. Phys. Res. B **409**, 264-267 (2017), doi: 10.1016/j.nimb.2017.04.051
[2] M. Laitinen *et al.* Nucl. Instr. Meth. Phys. Res. B **337**, 55-61, (2014), doi: 10.1016/j.nimb.2014.07.001

* This work was supported by the European Regional Development Fund under Project No. ITMS2014+: 313011BUH7, grant Agency VEGA under contract 1/0558/24.

† Presenting author email: jozef.dobrovodsky@stuba.sk

Isobar analysis in the actinide range for the characterization of a prospective Np spike material

A. Wiederin[1,2], M. Martschini[1], A. Sakaguchi[3], P. Steier[1], A. Yokoyama[4], K. Hain[1]

[1]*University of Vienna, Faculty of Physics, Währinger Str. 17, 1090 Vienna, Austria*
[2] *University of Vienna, Vienna Doctoral School in Physics, Boltzmanngasse 5, Vienna, Austria*
[4]*University of Tsukuba, Institute of Pure and Applied Sciences, Tsukuba, Ibaraki 305-8577, Japan*
[4]*Kanazawa University, Institute of Science and Engineering, Kanazawa, Ishikawa 920-1164, Japan*

^{237}Np ($T_{1/2}$ = 2.1 Ma) is the second most abundant anthropogenic actinide in the environment and has great potential as an environmental tracer complementing the already established radionuclide tracers ^{239,240}Pu and ^{236}U. However, the lack of an isotopic Np spike impedes the normalization of mass spectrometric, and in particular AMS (Accelerator Mass Spectrometry) results. Such an isotopic spike material is currently under development and a small quantity has been produced via the ^{232}Th(^{7}Li,3n)^{236g}Np reaction at the RIKEN Nishina AVF cyclotron. The co-production of ^{236}U and ^{236}Pu necessitates an elaborate chemical separation of U and Pu as well as fission products from Np as developed by the University of Tsukuba.

A combination of three approaches in AMS can now be used to characterize this prospective Np spike. In a first step, the ratio of ^{236}X/^{237}Np of the purified materials is determined in an AMS measurement on the actinide beamline at VERA (Vienna Environmental Research Accelerator). A new method for the isobaric analysis of mass 236 is primarily based on the element-specific anion formation ratio of AnF_4^-/AnF_5^- of the three actinides (An) in question in the AMS ion source. This separate measurement uses oxide-actinide targets mixed with PbF_2 for in-situ fluoridation of the actinides in the SNICS (Source of Negative Ions by Caesium Sputtering) ion source at VERA. Isobaric interference in a sample could be identified by a deviation from the calibrated NpF_4^-/NpF_5^- formation ratio.

The novel ILIAMS (Ion-Laser InterAction Mass Spectrometry) method has been applied in the actinide range for the first time to complement the anion formation isobar analysis. ILIAMS combines a gas-filled radio frequency quadrupole acting as an ion cooler for radial beam confinement with high-powered lasers or element-selective gas reactions to separate isobars in an AMS measurement. A new 637 nm laser setup for separating ^{236}U and ^{236}Np has been implemented, and ^{236}Pu can now be screened directly via the suppression of both ^{236}U and ^{236}Np when admixing oxygen to the buffer gas. These methods have been used to characterize a preliminary ^{236}Np pilot spike. The ^{236g}Np yield of the ^{232}Th(^{7}Li,3n)^{236g}Np reaction was significantly lower than initially calculated but a small quantity of this material is now ready for a first set of environmental samples.

This work has received funding from the Austrian Science Fund (FWF): [I-4803-N] and was supported by the Vienna Doctoral School in Physics, the Japanese Society for the Promotion of Sciences, and the ERAN network.

* Presenting author email: andreas.wiederin@univie.ac.at

Recent development in ion micro-beam instrumentation at NPI Řež

Vladimír Havránek *, Olexander Romaněnko, Petr Malinský, Romana Mikšová, Maria Cutroneo, Jiří Vacík, Anna Macková

The ion micro-beam line, based on OM Triplet and QMDAQ control system was installed at 3MV Tandetron 4130MC accelerator at Řež in 2009. Since that we have done several technical improvements in order to fulfil the needs of current research in our Laboratory. It includes the software for advanced scanning and spectra acquisition mainly for applications in IBW and for transfer to digital spectroscopic lines based on XIA PIXIE a XMAP and Amptek DP5 modules. Further we have install a new target chamber with precise 3-axis piezoelectric stage, allowing s sample positioning in sub micro-meter range and full 360 deg. rotation for application in STIM, PIXE and RBS tomography. Beside the routine H and He beams focusing we have used also heavier ion as C, N, O and Cu for applications mainly in IBW and single ion irradiation for producing regular patterns in thin polymeric foils. The description of ion beam line, focusing and software control and some examples of its use will be present.

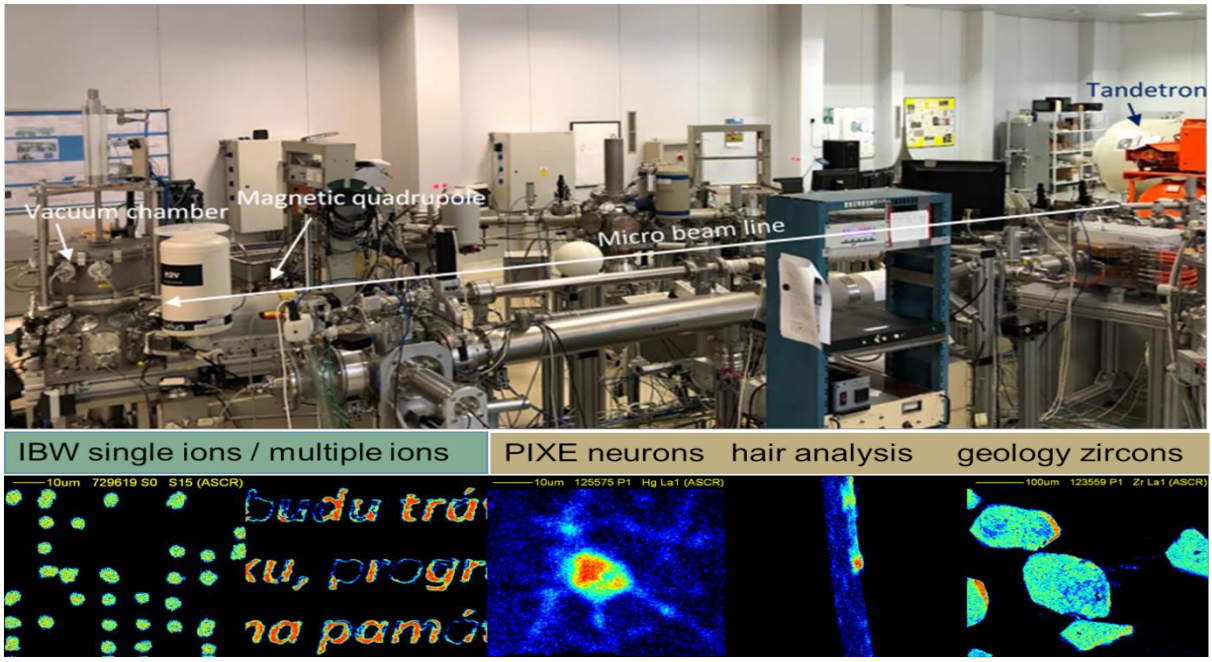

Figure 1- Ion micro-beam line at NPI Řež and some examples of its use in IBW and in analytical mode

The research has been carried out at the CANAM (Centre of Accelerators and Nuclear Analytical Methods) infrastructure LM 2015056. The authors acknowledge the assistance provided by the Advanced Multiscale Materials for Key Enabling Technologies project, supported by the Ministry of Education, Youth, and Sports of the Czech Republic. Project No. CZ.02.01.01/00/22_008/0004558, Co-funded by the European Union." – AMULET project.

* Presenting author email: havranek@ujf.cas.cz

Induced effects of protons irradiation on some physical properties of ZnSe & ZnTe thin films

Kim KeunHwan[1, 2], Iftimie Sorina[2], Radu Andrei[1], Iancu Decebal[1], Mereuta Paul[1], Vlad-Andrei Antohe[2], Claudiu Locovei[2]
[1]Horia-Hulubei National Institute of Physics and Nuclear Engineering
[2]University of Bucharest, Faculty of Physics

Zinc selenide (ZnSe) and zinc telluride (ZnTe) are A^{II}-B^{VI} semiconductors, with promising results in the field of photovoltaic devices. Even though the heterojunction cadmium sulfide / cadmium telluride (CdS/CdTe) proved to be a suitable candidate to replace a part of the silicon technology, with good performances for terrestrial and space applications, the hazardous properties of cadmium request the finding of a better solution. In this sense, binary compounds based on zinc (Zn) can be an alternative. Until now, the majority of studies related to ZnTe, as an absorber layer, reported solar cells for terrestrial applications, while space utilization was scarcely discussed.

This study analyzes and discusses the effects of proton irradiation on the optical, morphological, structural, and electrical properties of ZnSe and ZnTe films. Previous results obtained for CdS/CdTe-based photovoltaic structures indicated an increase of point-like defects density at the “window” layer / active layer interface, together with a decrease in the external quantum efficiency. Other studies showed that when zinc oxide was used as transparent conductive oxide instead of indium tin oxide, the overall stability against ionizing radiation was improved.

To obtain a proper heterojunction, as a ” window” layer, instead of CdS, our proposal was ZnSe, which will be also irradiated with protons and its physical properties will be investigated, using the same approach as in the case of ZnTe film. In this manner, knowing the behavior of both components of a possible junction, we can predict the performance of some devices.

We choose protons because they represent 80% of the ionizing radiation in space, while fluency and energy are similar to studies from the literature, involving CdTe.