Improvements at the radiographic analysis of radioactive targets

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Radiographic imaging (RI) is commonly used in life sciences to characterize radio labeled thin films, tissue sections, and electrophoresis gels. It can also provide information about the homogeneity and the thickness of radioactive targets on thin backings.

The newly available equipment at the institute for nuclear chemistry at UMZ is a FLA 7000 by FUJIFILM Corporation*. This system is originally built as a multipurpose bio-imaging system for fluorescence dyes and medically relevant radioisotopes using reusable imaging plates (IP). The imaging plates are available for β - and γ-emitters, for weak β- and α-emitters as well as for neutron detection.

The imaging plates consist of crystallites with sizes of 25 µm or 50 µm, depending on the IP. Each of the crystallites can be brought into an excited state by radiation and then analyzed by a 650 nm laser beam in the system. The experimental spatial resolution of the equipment has been determined by measuring a neutron activated gold wire with a thickness of 2.5 µm. The achieved resolution for ^{198}Au (E_β= 1.0 MeV, E_γ= 412 keV) was < 200 µm. With this, the resolution is improved by a factor of 10 compared to the formerly used autoradiographic imaging system [1]. The experimental resolution for uranium of the new equipment has not yet been determined. The imager is suitable for the direct determination of target thicknesses of actinide targets and for the investigation of their homogeneity.

In first investigations, the target thicknesses of thermally evaporated UF_4 targets (made at GSI) have been verified by the imaging system and were compared to the thicknesses determined by a microbalance at GSI. Figure 1 shows the radiographic image of these targets.

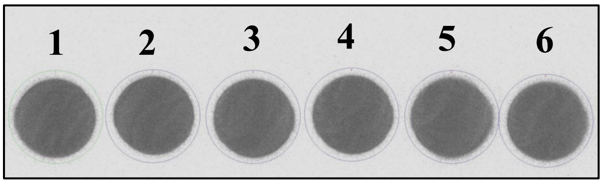

Figure 1: RI of the UF_4 targets

The uranium contents in targets # 2-6 were determined relative to target # 1, which was used as "standard". The deviations range from 0.16 to 4.6 %, which is considered as good agreement, as listed in Table 1. From this, one can also conclude that there is no significant difference in the detection efficiency for the area covered by these six targets.

These results are in good agreement with an additional experiment investigating α-decaying plutonium targets. Here, the content of two ^{240}Pu samples with a known activity of 1.01 kBq and 0.087 kBq were determined and compared to each another.

Table 1: Thicknesses of the UF_4-targets determined by GSI and the FLA 7000 system

Target No	FLA 7000 [µg/cm²]	GSI [µg/cm²]	Deviation
1	„Standard“	389	**0.00 %**
2	376,4	377	**0.16 %**
3	360,3	364	**1.02 %**
4	363,4	369	**1.53 %**
5	363,3	381	**4.64 %**
6	364,9	372	**1.90 %**

In-depth studies with regard to the target thickness determination by the imaging system are still in progress. Especially, the preparation of standard actinide samples for a frequent use is under way.

Other investigations with the imaging system focus on its usability to survey the target layer homogeneity of uranium layers made by molecular plating. Here, the new system offers an improved resolution and better functional software compared to the formerly used equipment. Figure 2 shows the radiographic image of an uranium layer deposited on a tantalum backing.

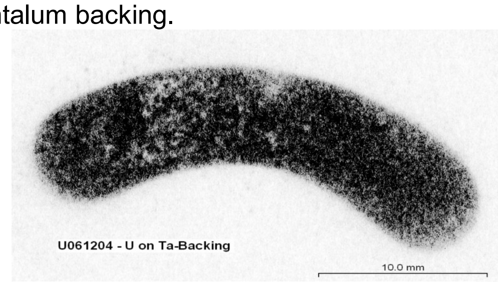

Figure 2: RI of an U-Target on Ta-Backing

The thickness of the U-layer is 410 µg /cm² as determined by neutron activation analysis. The deposition seems rather homogeneous in the right part of the target. Beginning from the middle towards the left, the layer in the image looks more inhomogeneous. The radiographic image confirms the inhomogeneity of the deposition of the target in reality. The central and the left part of the target have lost material and look furrowed, because the deposition layer was stressed when the target was dismounted from the deposition cell.

References

[1] Liebe, D. et al, "The use of autoradiographic imaging for monitoring target thickness and homogeneity", Annual report, GSI, 2005

* *in property of GSI*