Autoradiographic Imaging of Uranium Targets

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Molecular plating is commonly used to prepare lanthanide and actinide targets. Subsequently to the plating procedure, the deposition yield is determined indirectly by analyzing the supernatant solution [1]. Alternatively, autoradiographic imaging offers the possibility to investigate the target surface itself, in order to obtain information about target thickness and homogeneity of the deposition layer. Autoradiographic imaging is a mapping of the radioactivity of a material, which is distributed over a certain area. The equipment used here is an InstantImager® by Packard Instrument Company with a rectangular detection area of 20 x 24 cm.

Determination of imager resolution

The spatial resolution given by the manufacturer is 0.5 mm for C-14 (E_β = 0.2 MeV) [2]. In previous tests, a resolution of about 1.5mm has been determined for Au-198 (E_β = 1.0 MeV, E_γ = 412 keV). A gold wire with a diameter of 25 µm was neutron activated and subsequently analyzed by the Imager®. For uranium, the resolution has been appointed recently to ≥ 2 mm. Here, 2 mm-spots of deposited uranyl nitrate were arranged regularly on a Plexiglas carrier with a defined distance of 4mm between each other, see Figure 1. After neutron activation, the images of the uranium spots almost merge into each other despite of their distance.

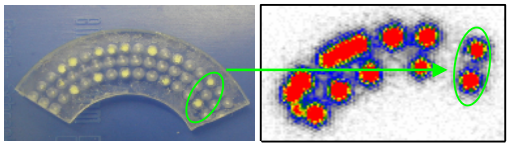

Figure 1:
Sample carrier with uranyl nitrate and its autoradiographic image after irradiation. The framed uranyl nitrate spots a have a distance of 4mm between each other.

Imaging of UF_4 - Targets

In Figures 2 and 3, the autoradiographic images of two UF_4-Tagets are shown. These targets, which were made by vapor deposition at GSI, have a thickness of 350 µg U/cm² on a carbon backing with an total area of 31,7cm². They are additionally covered by a 10 µg/cm² carbon layer. The lower target (B) has already been irradiated by a Ca-48 beam at GSI, the upper one (A) has not been irradiated. To obtain comparable results, both targets were measured simultaneously for 18h. Generally, from these images, one can conclude that the target material is distributed over the whole area with a maximum in the centerline. The irradiated target shows a loss in total counts of about 10% compared to the non-irradiated one. To judge if this loss is due to the interaction with the ion beam [3], one has to check for possible shifts in the detection efficiency over the entire detection area. Corresponding studies with uranium targets (UF_4 on Al, also made at GSI by vapor deposition) used as standard samples are currently performed.

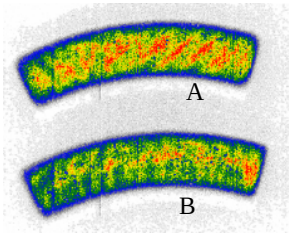

Figure 2:
Autoradiographic image of UF_4-Targets from GSI with 350 µg/cm² U, Imaging time 18h

A: non-irradiated
B: irradiated (^{48}Ca)

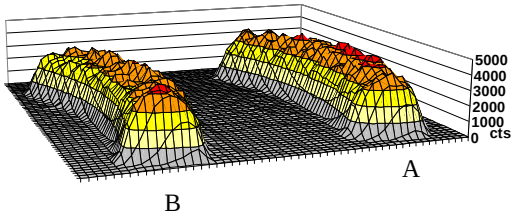

Figure 3:
3-D diagram of the Targets from Figure 2
Target area is 31.7cm².
A (non-irradiated): 1,557,371 tot. gross cts.
B (irradiated by ^{48}Ca): 1,472,885 tot. gross cts.

Basically, autoradiographic imaging with the InstantImager® is helpful to obtain general information about target surface by using uranium as target material. For quantitative information about target homogeneity and thickness a higher resolution is preferable.

References

[1] D.Liebe, P. Thörle, J.V. Kratz "Further investigations on target preparation for heavy element studies", Annual report 2004, Institut f. Kernchemie, Universität Mainz, (2005)

[2] Packard Instrument Co. Inc., Reference Manual, Public. No. 169-4106 Rev.H, R15 (1996)

[3] TASCA Targetgroup Meeting GSI, 25.July 2005, www-w2k.gsi.de/tasca