Target Developments for the Search of Picosecond Fission Isomers ◊

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Our experimental program to search for short-lived (ps) fission isomers in light actinides using the projection method as described in detail in Ref. [1] has been continued, however a new detector material had to be chosen since the previously used BG24A phosphate glass filter plates were not any more produced by Schott AG. Therefore the filter glas UG5 with similar properties as BG24A was tested, proving to be suited for being used as track detector. It turned out that etching times had to be reduced from 3 hours to 1.5 hours in order to achieve the same track radii. While the projection method in principle offers a straightforward and simple experimental access to short-lived fission isomers in the picosecond range, the method critically depends on the quality of the plunger-type targets with a planarity requirement of better than 0.5 μm, leading to a sharply defined shadow edge and azimuthally isotropic distributions of isomeric fission fragments at short projection lengths. Whereas with conventional metallic foils (Ni, Ti, Cu), as used in the early experiments of Metag et al. [2], it was impossible to reach this target quality, the actual target development concentrates on the use of etched thin SiN membranes as carrier surfaces for the target material. A customized mask for Si wafers (5x5 mm^2, 300μm thick) with central, 300 nm thin etched SiN membranes (1.5 x 1.5 mm^2 and 1.8 x 1.8 mm^2 window size, adapted to the beam dimensions) was produced by the company Leister (Switzerland) and individually cut membranes were purchased. Fig. 1 shows a target holder with the SiN membrane glued on top of the square socket part.

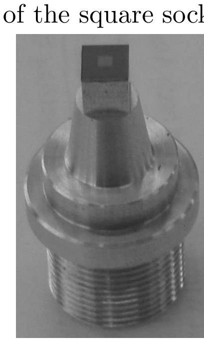

Fig. 1: Photograph of the target holder equipped with a thin SiN membrane as carrier foil for the ^{232}Th target spot.

While last year's experiments already proved the thermal stability of the membranes for beam currents of up to 250 nA, thermal stress effects were studied in more detail this year. Fig. 2 shows photographs taken through the lens of a microscope (enlargement 50) of the SiN membrane before (left) and after (right) irradiation by the 24 MeV α beam (100 nA beam current for 15 hours). The rectangular etched membrane window and on top the circular spot of the evaporated target material (^{232}Th, 30 μg/cm^2) is visible. While the overall integrity of the membrane was preserved during beam bombardment, besides traces of the beam interaction with the SiN material surface damages of the irradiated membrane can clearly be identified in the corners of the membrane window.

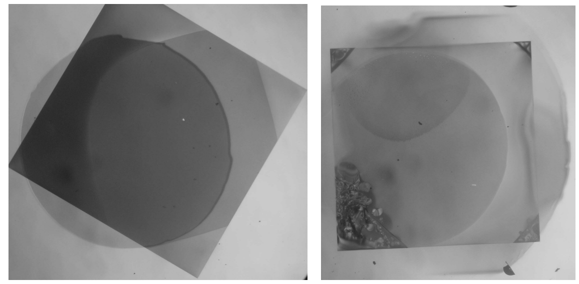

Fig. 2: Central part of the Si wafer with the rectangular SiN membrane window seen through a microscope (x50). Left: SiN membrane with circular ^{232}Th target spot before irradiation with 24 MeV α-beam. Right: SiN membrane with target spot after 15 hours irradiation.

This strongly indicates thermal expansion during irradiation, in agreement with the experimental findings of the azimuthal distribution of the isomeric fission fragment track density derived from the six track detector plates arranged in a hexagonal cylindric geometry around the target, shown in Fig. 3. Certain azimuthal regions exhibit deviations from the expected flat and sharply-defined prompt fission edge. 'Burst'-like structures of tracks in the region beyond the prompt shadow edge were observed which cannot be attributed to real fission isomers. Electrostatic charging of the track detector glass plates leading to an electrical field acting on the highly-charged fission fragments was avoided by coating the detector plates with a thin (30 μg/cm^2) layer of Titanium.

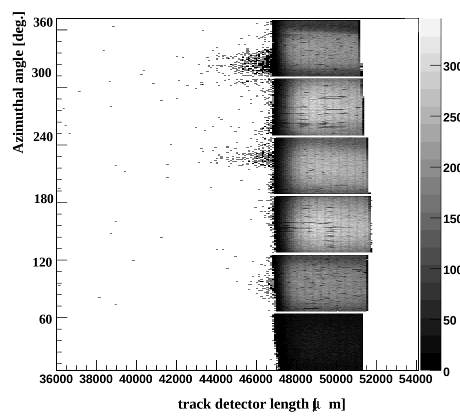

Fig. 3: Azimuthal distribution of the fission fragment track for a set of six track detector plates surrounding the central target in the reaction ^{232}Th(α,2n)^{234}U (24 MeV). 'Burst'-like structures, most likely originating from a (local) thermal expansion of the target material are visible.

Modifications of the target to be tested in an upcoming experiment include an improved thermal coupling of the Si wafer to the aluminum holder with exchanging the previously used epoxy glue by a metallic glue with high thermal conductivity (7.8 W/(m·K)) assisted by a thin Cu coating of the Si surface.

References

[1] P.G. Thirolf *et al.*,Annual report 2003, p. 22
[2] V. Metag *et al.*, Nucl.Instr.Meth. **114** (1974) 445

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