Enriched ^{148}Nd Target on Ultra Low-Density Backing

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Introduction

This paper describes the method used for preparation of enriched ^{148}Nd target for gamma ray spectroscopy using Silica Aerogel as the backing material. The use of ultra low-density aerogels as backing material is aimed to increase sensitivity of the DSAM method over longer lifetimes. The gamma spectroscopy results obtained using this target are submitted as a separate contribution.

The first aerogel was prepared in 1931 by Steven. S. Kistler [1]. Aerogel is a synthetic porous material with nano size cavities derived from a gel with its liquid component replaced by air. In the present work, commercially available Silica based aerogel from M/s BuyAerogel [2] were used with a quoted density of 0.095 g/cc.

Although aerogel can sustain high stress (it can support up to 1000 times its "own weight"), there are practical difficulties due to its extreme low weight and highly brittle nature (a less careful touch can shatter it instantaneously into a million pieces). Hence, a sample holder which ensured easy maneuvering of aerogel has been fabricated.

The Target Holder

The fragile aerogel, in the shape of a disc with a curved top surface did not allow us to use the conventional measuring devices (such as Vernier Calipers). An indirect measurement technique using a digital camera and scale was adopted to obtain the dimensions and shape of the aerogel (Fig. I).

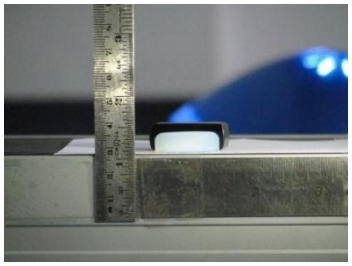

Fig. 1 Silica based Aerogel

Perspex was chosen as the holder material, and the dimensions were designed in such a manner that free movement of aero-gel within the holder is almost ceased, while not exerting any pressure/stress. Care was taken to minimize any extra material in the holder at the same time not compromising on the mechanical strength of the assembly. The dimensions of the holder are illustrated in Fig .II.

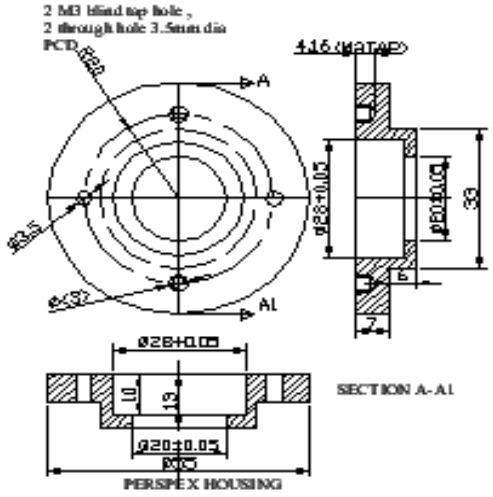

Fig. 1I Design of the Perspex sample holder

Fig. III Aerogel with the sample holder

Electron beam evaporation

The major challenges that were encountered during the electron-beam evaporation, were (i) the evaporation losses had to be minimized, (ii) the conventional thickness measurement technique of using the energy loss of alpha particles passing through the foil could not be employed, as the 5.41 MeV alpha particles are completely stopped in the aerogel.

The first problem was successfully circumvented by using a specially designed crucible to increase deposition efficiency by reducing the solid angle dispersion during evaporation specially designed crucible and reducing the crucible-substrate distance significantly to 5 cm. This was finalized after a few trial runs to ensure that the aerogel material could withstand the heat at such close distance.

The solution to the second problem was obtained by carefully mounting the aerogel and a Ta foil in close proximity, such that they received almost identical evaporated material. The thickness of the material evaporated on the Ta foil could be measured from the conventional alpha spectroscopy technique and the results were in close agreement with the thickness monitor readings. Both these were in reasonable agreement with the expected / calculated thickness. This provided a reasonable method to estimate the thickness of the material evaporated on to the aerogel. Several test runs were undertaken to ensure reproducibility of the results. Positioning of crucible was a very delicate job as proper precaution must be taken to ensure the visibility of the crystal monitor throughout the evaporation process in this compact and complex arrangement. During the runs no appreciable degradation in the vacuum conditions were observed and the typical current was about 72 mA, where as vacuum throughout the process was about $2*10^{-7}$ Torr.

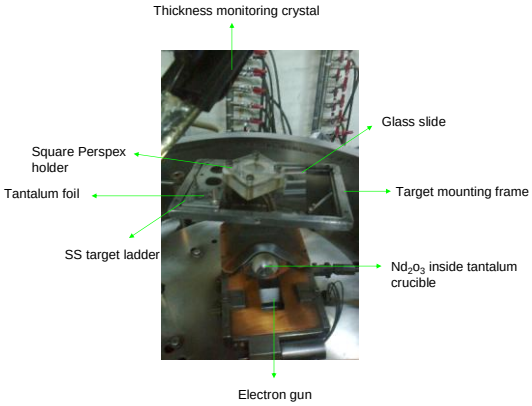

Fig. IV Mouting arrangements in the E-beam deposition unit at IUAC

After the evaporation, without breaking the vacuum a gold coating of about 20 µgm/cm^2 was deposited on the Nd_2O_3 . This gold coating was intended to protect the Nd_2O_3, a highly hygroscopic substance.

After the successful evaporation the aerogel backed targets were successfully transported back to Kolkata en route to TIFR Mumbai for experiments with INGA. Special attachment was designed to couple the entire perspex holder with the existing target ladder at TIFR, such that the evaporated material is at the centre of the conventional target position. The fabricated attachment also allowed the use of two targets (i) with the Ta backing and (ii) the aerogel backed material.

The experimental results indicated the population of the nucleus with expected statistics and hence has established the methodology for evaporating targets on this novel backing.

We thank Prof Gavin Smith, University of Manchester for making the aerogel available to us.

References

[1] http://www.sps.aero/Key_ComSpace_Articles/TSA-009_White_Paper_Silica_Aerogels.pdf.
[2] http://www.buyaerogel.com.