Fabrication and characterization of thin Nickel (^{61,62}Ni) targets

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Introduction

To measure fusion excitation functions and the barrier distribution using recoil separator through Heavy Ion Recoil Analyzer (HIRA) [1] at Inter University Accelerator Center (IUAC), New Delhi, India, a good quality, uniform and thin self supporting targets are preferable. Since the fabrication of such targets is very difficult, a considerable thin carbon foil as a backing is needed. Some trials of fabrication of carbon-backed targets were done with natural Ni. After optimizing the parameters, required isotopic targets (^{61,62}Ni) were fabricated.

Various procedures and backing composition of Ni target fabrications are available in literature. Refs. [2] and [3] reports the fabrication of self supporting Ni target using rolling technique and evaporation technique respectively, ref.[4, 5] says about the fabrication of Ni target on large area (for document imaging) and fine plastic-backings. In this abstract, preparation of a carbon backed thin target of enriched ^{61,62}Ni ($\approx$ 100-150 $\mu g/cm^2$) isotope using a physical vapour deposition technique (thermal evaporation) has been reported along with the essential steps and the precautionary measures considered for successful fabrication.

Experimental set up

Fig. 1 shows the picture of diffusion pump based coating unit (DPU) and the turbopump based coating unit (TPU), in the target laboratory of IUAC. DPU is connected with a diffusion pump and is equipped with single pocket 2 kW e-gun and resistive heating arrangement. TPU is connected with a turbo molecular pump and a scroll pump (used as the backing). This chamber is equipped with electron beam bombardment assembly consisting of 6 kW multi-pockets e-gun. Chilled water is circulated through the chamber to maintain them at room temperature. Throughout the evaporation, the vacuum was maintained in the order of 10^{-9} mbar in TPU and 10^{-7} mbar in DPU. A piezoelectric crystal-based thickness monitor was kept inside both the coating units to monitor deposition of thin films with time.

FIG. 1: The DPU (left) and TPU (right)

Fabrication of carbon backing

To prepare carbon-backed target, the first step is to prepare carbon foil. A parting agent, KCl, is taken along with carbon source, viz., graphite and are enclosed in the DPU chamber simultaneously. Using thermal evaporation, KCl of 120 nm thickness was deposited on the clean glass slide (as substrate) kept at 18 cm from the source. The deposition rate was around 0.1 nm/sec. After that, C of thickness 100 nm($\approx$ 30 $\mu g/cm^2$) was deposited over KCl on the slides (17 cm away from the C source) by e-gun without disturbing the vacuum. After cooling the chamber, it was vented

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following which the C slides were taken out and then annealed in a tubular furnace (fig. 2) at a temperature of 250^0C for 1 hour in the Argon gas environment to relieve the internal stress which may get developed during evaporation.

Fabrication of thin ^{61,62}Ni isotope on C backing

Using TPU thermal evaporation, ^{61}Ni was first deposited on the fresh annealed C slides, kept at 15 cm from the source, at the rate of 0.1 nm/sec at 360 A current. After evaporation, the chamber was left for few hours for cooling followed by venting and then the deposited material is taken out. The floating was done to separate the deposited target material from the slides by dissolving the parting agent through the slides in the warm distilled water. The floated target is then hold by appropriate target holder. Same procedure was repeated for ^{62}Ni in the next round of evaporation with freshly prepared C slides kept at the same distance as in the previous case. The condition and the parameters were kept the same. The target thickness is verified with the profilometer.

FIG. 2: The tubular furnace

Characterization of target.

Impurities are analyzed using the energy dispersive X-ray spectrometry (EDS) technique [fig.3] and the Rutherford backscattering spectrometry (RBS) technique [fig.4] at IUAC. It was found that apart from Ni, C (backing elements), no other distinct peaks can be seen indicating the absence of any other heavy impurities. Even target thickness is also verified using RBS. The thicknesses for ^{61}Ni and ^{62}Ni are found to be 100.2 $\mu g/cm^2$ and 148.4 $\mu g/cm^2$ respectively.

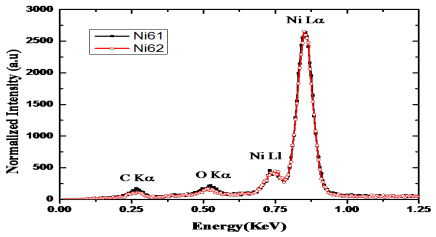

FIG. 3: The EDS spectra of ^{61}Ni and ^{62}Ni

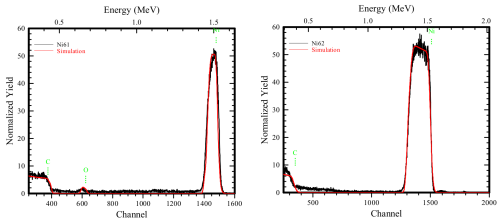

FIG. 4: RBS spectra of ^{61}Ni(left) and ^{62}Ni(right)

Results and Conclusion

Thus, stable ^{61}Ni and ^{62}Ni target of thicknesses $\approx$100 $\mu g/cm^2$ and $\approx$150 $\mu g/cm^2$ respectively are successfully prepared on carbon backing of 30 $\mu g/cm^2$. These targets are then kept properly in the desiccators to be used for the upcoming experiments.

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