Preparation and characterization of a Nb-93m target

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We have prepared a thin Nb-93m source using the well-known molecular electroplating technique[1]. To develop the procedure, an aliquot of initial Nb-93m solution in 1 M HNO_3/0.3 M HF was used. The niobium electrodeposition was optimized at a level of 3-5 mA/cm^2 current density. The efficiency of niobium deposition was increased up to 95% for relatively low carrier concentration, the entire procedure taking 2 hours. This was the result of careful purification of isopropanol (the main organic solvent in the target cell) and the aluminum disk (an arbitrary material chosen for the source backing). Apparently, electrochemical removal of water from the solvent, and the oxide layer from the disk (2.275 cm^2) helped to significantly improve the yield of the electrochemical process.

In all, we prepared 5 sources on aluminum backings and subsequently tested each of them by measuring the emitted low energy gammas and X-rays. The source with the highest activity deposited (~4.5 μCi) had an areal density of ~1.3 mg/cm^2. Fig. 1 shows deposition parameters and the gamma-spectrum of the most active source. The electrodeposition method we employed is limited to 1-2 mg/cm^2 of material deposited, so it was decided not to increase the layer thickness to avoid any possible loss of deposited activity from flaking, cracking, and peeling of the thick film. Most likely, a very high concentration of electrolytes affected the procedure and resulted in one source requiring an increased deposition time (15 h) while having a reduced deposition efficiency (~50%). It should be noted that, consistent with our previous studies, energy dispersive spectroscopy (EDS) and X-ray photoelectron spectroscopy (XPS) demonstrated that niobium was deposited in the form of pentoxide Nb_2O_5, despite the presence of nitrates and oxyfluorides in the solution.

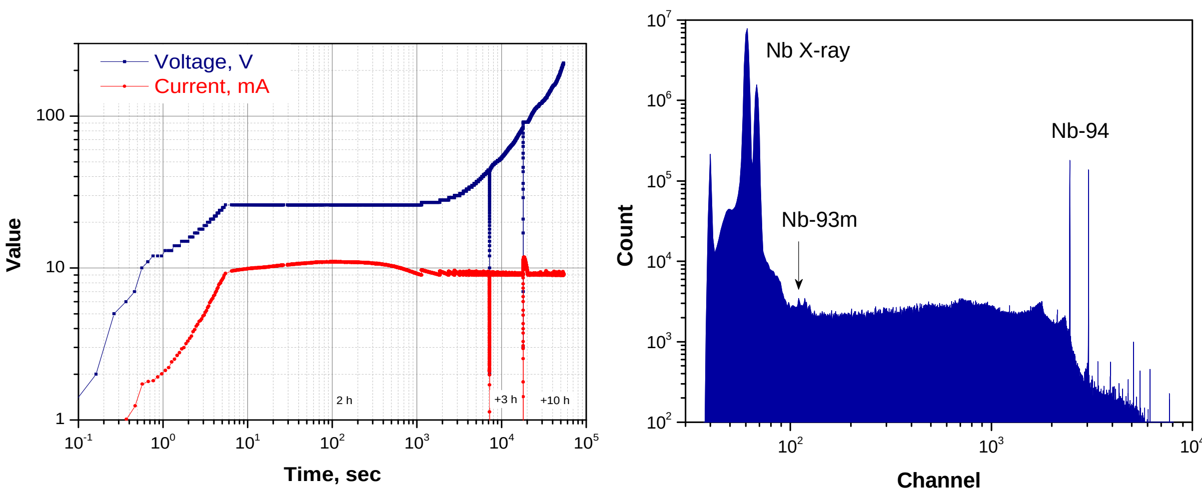

FIG. 1. (Left) Voltage and current parameters during the target preparation. (Right) HPGe-detector spectrum of the target (69 h).

This set of targets will be used to determine the effect of self-absorption on low energy X-rays. With this established we will make a long-term decay measurement using the most active source, to make a precise determination of the internal conversion coefficient for the decay transition from Nb-93m.

[1] D.A. Mayorov, E.E. Tereshatov, T.A. Werke, M.M. Frey, C.M. Folden III, Nucl. Instrum. Methods Phys. Res. **B407**, 256 (2017).