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Aluminum Target Thickness

Summary

For our second target we have obtained 99.999+% pure Aluminum foil, nominally 75µm thick. I fabricated targets before measuring the thickness of the foil. We had four sheets and all four sheets were used in attempts to fabricate a target plane. Subsequently two target planes were kept as useable and two were rejected. From the leftover pieces I have measured the thickness of the Aluminum using two methods. One method was a direct measurement with a micrometer. The other method was to weigh the foil pieces and measure their area, then use this information to calculate the thickness. The thickness measured is 71µm ± 1µm.

Method

We ordered 4 sheets of Al foil 150mm x 150mm, and 150 mm disks were cut out of these leaving 16 roughly triangular pieces. From the two rejected targets I got two disks roughly 120mm in diameter free of epoxy. I wanted straight edges to measure and I was further constrained in how I cut the pieces because I wanted to subsequently cut 25mm diameter disks out of them for µsr studies. So the disks were each cut into three pieces consisting of a rectangle and two six sided shapes. The 16 corner pieces were trimmed to give 45° triangles.

The thickness of the pieces was measured directly using a vernier micrometer with a resolution of .0001 inch, or 2.5µm. Then for comparison the pieces were weighed on a milligram scale and the areas measured. Dimensions of the triangles were measured using a profile projector with a resolution of 1µm but an accuracy of ±10µm. The short dimension of the rectangles and six sided shapes could be measured on the profile projector but the long dimensions had to be measured with a vernier calipher and had an accuracy of ±50µm.

Data

Sample	Thickness	
	Micrometer	From Weight
	μm±1.3μm	μm±.20μm
1	68.6	70.70
2	68.6	71.83
3	73.7	73.76
4	71.1	71.72
5	73.7	75.11
6	68.6	70.03
7	68.6	69.81
8	68.6	69.70
9	66.0	69.86
10	68.6	70.57
11	73.7	73.02
12	68.6	69.77
13	71.1	72.27
14	73.7	74.57
15	68.6	70.52
16	71.1	72.97
A1	72.4	73.24 ±.07μm
A2	71.1	73.46 ±.11μm
A3	68.6	71.01 ±.11μm
D1	74.9	76.62 ±.05μm
D2	74.9	76.36 ±.11μm
D3	73.7	76.09 ±.11μm

Conclusions

1. The average material thickness from all the samples is 72.4μm with σ=2.3μm.

2. We can do somewhat better than this because the material can be grouped. Samples A1, A2, and A3 are from one sheet, while samples D1, D2, and D3 are from another sheet. Four triangles can be grouped with each of these. While there is some speculation in the groupings I have chosen the following groups.

D1,D2,D3,3,5,11,14 Average thickness=75.1μm σ=1.4μm

A1,A2,A3,1,10,13,16 Average thickness=72.0μm σ=1.3μm

Leaving the following groups

7,8,9,12 Average thickness=69.8µm σ=.07µm

2,4,6,15 Average thickness=71.0µm σ=.9µm

So the target foil must be either 70µm or 71µm thick. For a more accurate assesment the actual target would have to be weighed, a destructive test.

3. From samples A1, A2, and A3 which are all from the same sheet, it can be seen that the material can vary by 2µm in thickness, or ±1µm .

4. There is a systematic error between the micrometer readings and weighing to get the thickness. The micrometer reads lower by 1.6µm with a σ=1µm for this difference.