Targets for nuclear physics studies

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What is the target?
What is the target?
What is the target?
What is the target?
How to make the target?

The choice of the method depends on many aspects:

- target characteristics/parameters
- costs of the materials
- availability of the tools/method in the target lab
- effectiveness
- avoiding contamination of the material (as far as possible)
How to make the target?

Target properties

Target material: element-isotope and its state: solid, liquid, gaseous

Thickness

Chemical form required and available

Self-supporting or on the backing

popular backings:
- thin metal foils
- carbon foil
- plastic: Mylar, Kapton, Formvar

120 µg/cm² Au on 35 µg/cm² polyimide foil
How ???

mechanical shaping:

rolling

tablet pressing
chemically: electro-deposition from hydrous or organic medium

(always on the backing)
How ???

deposition in the high vacuum

Substrates rotation (to improve the thickness homogeneity of the deposited layer)

resistance heating
e-gun
How ???

deposition in the high vacuum

sputtering
How??

carbon evaporation:
arc
e-gun
laser ablation
Resistance heating
• The method is very simple, robust but limited to the materials of the low melting point (not higher than 1500 °C) and not alloying with the boat material (typical boat material is Mo, Ta, W).

E-gun
• The method is more complex, but extremely versatile. Can achieve temperatures in excess of 3000°C.
• Use evaporation cones or crucibles in a water cooled copper hearth.
• Typical emission voltage is 8-10 kV.
• but exposes substrates to secondary electron radiation.
• X-rays can also be generated by high voltage electron beam

Sputtering
• the method can be applied to the most of the materials except those which can degrade due to ionic bombardment
• this technology allows to released the deposited material at much lower temperature than evaporation.
• gives easy film thickness control via time, allows alloy deposition, no x-ray damage
• requires rather big surface of the sputtered material to avoid bombarding of the cathode material. There is as well big chance for the impurities incorporated due to low vacuum.
How ???
Target characterisation

Thickness:

(mass/area i.e. g-mg-µg/cm²)
1 b (σ) = 10^{-24} \text{ cm}^2

it’s approx. the sectional area of the U nucleus

The unit was created during II WW

Physicists working on Manhattan project to keep their discussions on problems related to the atomic bomb production in secret were meeting in the barn.

As legend wants discussing the probability of hitting the U nucleus by neutron one said ‘it should be no problem as U nucleus comparing to the neutron is like the barn in which we are’
**Thickness estimation:** mass/area i.e. g-mg-µg/cm²

- mechanically i.e. caliper, micrometer (screw??)
- weighing the defined area
- in-situ during the vapour deposition process using the quartz microbalance
- spectrophotometrically
- measurement of the α particles or X-ray energy loss
- profilometers working in a contact or non-contact modes
Thickness estimation of the active targets:

if made by evaporation: during preparation with quartz microbalance

ready target: measurements of the activity

thickness homogeneity by activity scan across the target area
Target characterisation

\textit{Thickness}: \textit{(mass/area i.e. g-mg-\mu g/cm^2)}

\textit{Thickness homogeneity}:

?
Surface characterisation

Title:

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AFM images of tristearin layer
Target characterisation

**Thickness:** (mass/area i.e. g-mg-μg/cm²)

**Thickness homogeneity (including surface topography)**

**Purity/composition**
PIXE spectrum of polyimide foil

Target characterisation

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When ordering a target define the characteristic needed/significant for planned studies but avoid exaggeration i.e. do not order a target with much better characteristic than really needed. This may cause additional costs and/or delay.

- element/isotope
- thickness, dimensions
- supported or not, if yes what can be considered as support

Do not overestimate the importance of the chemical form of the target material

- not always have to be a pure elemental form, the compounds may suite your needs as well but often it is much easier (cheaper) to make the target from compound

Never blindly believe the sample characteristic quoted. Whenever possible check yourself the characteristics which are of essential importance to your experiment.

Discuss with target maker your planned target. Target preparation people can do sometimes more for you than you believe; it is often a question of communication and of raising the relevant problems/aspects.

Some target bibliography index on www.intds.org