RECENT DEVELOPMENTS IN THE TARGET FACILITIES AT ARGONNE NATIONAL LABORATORY

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ABSTRACT

A description is given of recent developments in the target facility at Argonne National Laboratory. Highlights include equipment upgrades which enables us to provide enhanced capabilities for support of the Argonne Heavy-Ion ATLAS Accelerator Project. Also future plans and additional equipment acquisitions will be discussed.

1. Introduction

The Argonne Physics Division operates a target fabrication facility which provides thin films for atomic and nuclear physics experiments, as well as for other scientific projects. These services are available to the Physics Division, other divisions of the Laboratory, and outside scientific institutions. In addition to the normal target production requirements, effort is spent on research in new areas of target development and in the implementation of advanced techniques developed elsewhere. The great majority of targets produced by the facility are for experiments at Argonne National Laboratory's ATLAS Facility.

The targets produced were either self-supporting or normally on carbon, gold or lead backings, and occasionally on stretched substrates. Support for ATLAS's Accelerator operations includes providing isotopic compounds for the ion source as well as carbon stripper foils when needed.

2. Physics Division Target Laboratory

The Physics Division Target Facility consists of a variety of equipment. Capabilities include apparatus for resistive heating, electron beam gun evaporation and sputtering. Auxiliary equipment provides support for numerous other activities. Our laboratory computer system is also mentioned.

A. Vacuum Evaporators

The Target Lab maintains four high vacuum evaporation systems, each of which is described below along with it's capabilities for the production of targets.

A NRC 3117 evaporator system with a Varian 6" diffusion pump and liquid nitrogen cold trap (maintained under high vacuum) is our primary apparatus for multiple resistively heated targets. Included within this apparatus is a Veeco Model VeB-6 electron beam gun system. P. Maier-Komor's[1] review paper on electron beam gun evaporation exemplifies some of the characteristics of this source. Tables 1 and 2 depict targets manufactured using these techniques.

A second system, a Veeco Model VE-775 vacuum evaporator also employs a Varian 6" diffusion pump stack with a cold trap. This secondary system is also capable of multiple resistive evaporations. The apparatus is primarily used for "quick" evaporations such as salt substrates to be subsequently used for isotopically pure targets along with routinely producing gold foils of various thicknesses. This apparatus has been consistently made available to visitors and students as the need arises.

A third, brand new system consists of a ultra-clean vacuum bell jar pumped by an Air Products model CSW-202 cryopump. Within this apparatus we have installed an Ion Tech saddle-field sputter source Model Fab 11N. A modified source of this design is described in detail by Muggleton.[2] Table 3 shows some targets produced using this sputter gun.

The above three systems are each equipped with Kronos Model QM-331 quartz crystal thickness gauges for monitoring vapor deposition along with thermocouple temperature sensors. These devices enable us to monitor a number of aspects of quality control in target production.

The last vacuum evaporation system to be described is a glow discharge apparatus. This piece of equipment has only recently been moved into our laboratory. It is pumped using a Sargent-Welch Turb-Torr Model 3133 turbo-molecular pump and employs a MRC high-voltage 5 kV DC supply to produce an argon plasma. In the past, it had been used to crack ethylene for the production of stripper foils, (G.E. Thomas et al.[3]) something we intend to become more involved with in the future when Argonne's Positive Ion ECR Source comes on-line. In the meantime, we have employed it for cleaning critical surfaces especially glass cells used for an experiment involving a polarized deuterium target.

All of the above evaporators are kept under high vacuum (10^{-8} Torr), and are monitored using Bayard-Alpert tubulated ion gauges and Granville-Phillips series 270 ionization gauge controllers. During deposition, pressures of 10^{-7} Torr can be maintained.

B. Auxiliary Equipment

In addition to our vacuum evaporation systems, the target laboratory has a significant compliment of auxiliary equipment to support our target making capabilities. Among them include a Frei & Borel type SE/EX rolling mill. Table 4 illustrates some targets rolled with this apparatus. Also we have Lindberg Furnace equipped with a gas manifold for use in hydrogen reductions. It has also been used for inert gas reductions and for vacuum annealing as well. A recently procured Forma Scientific Model 1854 laminar flow hood bench has provided us with additional bench space for floating difficult (thin) targets. An inert gas glove box (also of Forma Scientific) was made available for our use and now resides in the lab. It can be pumped under vacuum and has been employed in the production of targets which may oxidize quickly. We support a full compliment of precision balances including Mettler analytical and micro-balances along with a Cahn Model 4400 electro-balance.

C. Target Storage Facilities

The Target Laboratory employs three vacuum systems for the storage of fragile or vulnerable foils. The first is a highly automated vacuum storage device developed at Argonne. It consists of a turb-pumped (Sargent-Welch) chamber enclosing a rotating carrousel capable of holding up to 100 of our standard target frames. It is kept under vacuum (10^{-7} Torr) by active computer control. In other words, after a power shut-down, it will again pump down to a high vacuum condition automatically, thereby maintaining the integrity of the targets stored within it. A second, quite similar system has been constructed, although not under computer control. This automated chamber will be used for routine storage of targets for extended periods of time. It should relieve the burden of target storage within our Argonne built 12 station manifold for vacuum desicators. With targets now being stored in the 2nd storage system, we can increase the use of vacuum desicators for storage of oxidizing materials and foils.

D. Laboratory Personal Computer

Available in the lab is an IBM PC/XT computer currently running DOS version 2.1 Besides the computer system with its 2 hard disk drives, there is an enhanced graphics 5154 color monitor and letter quality IBM printer. We have made extensive use of this machine for purposes of chemicals and stable isotope inventories and a complete record, with cross-references, of all targets manufactured since 1978. In addition there are programs used to generate labels for identification of targets, boats and source compounds. We intend to further integrate this computer into laboratory functions in the near future.

3. Prospects for the Future

A new acquisition and two major projects have taken place within the target lab recently which will significantly enhance our capabilities for producing high quality targets. The purchase of a Temescal Model STIH-270-1 four-pocket turret electron beam source will enable us to now perform multiple electron beam evaporations. Equipment has been made available to us for the development of a laboratory for the production of low-level radioactive targets. Equipment will include a dedicated vacuum evaporator, micro-balance, etc. This facility anticipates the manufacture of targets necessary to support Argonne's ATLAS program upon completion of the new ECR Source, (the so-called uranium machine). Another recent project was the acquiring and transport of an isotope separation machine to Physics from the ANL Chemistry Division. We plan to operate this device for the production of targets in the near future.

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Table I. Resistively Heated Targets Produced

As Self-Supporting Foils	On Various Substrates
	$^{28}SiO_2$
$^{24,26}Mg$	^{40}Ca
Al	$^{46}TiO_2$
$^{58,64}Ni$	^{60}Ni
Ge	$^{74,76}Ge$
Ag	^{94}Mo
Sn	$^{119,120,122,124}Sn$
^{125}Te	^{122}Te
Au	^{138}Ba
	Hf
	$^{186}WO_3$
	Au
	^{208}Pb
	PbF_2
	Bi
	$^{144,150,154}Sm$
	^{160}Gd
	Tb
	Er
	Lu_2O_3
	Teflon {PTFE / TFE

Table II. Targets Produced By Electron Beam Evaporation

$^{10,11}B$	(Self-Supporting)
C	(Self-Supporting and for Coverings)
^{98}Mo	(Carbon Substrates)

Table III. Sputtered Targets (on framed carbon foils)

Ti
V
Cr
Zr
W
Pt