DESCRIPTION OF THE ARGONNE NATIONAL LABORATORY TARGET MAKING FACILITY

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Abstract

A description is given of some recent developments in the target facility at Argonne National Laboratory. Highlights include equipment upgrades which enable us to provide enhanced capabilities for support of the Argonne Heavy-Ion ATLAS Accelerator Program. Work currently in progress is described and future prospects discussed.

1. Introduction

The Physics Division of Argonne National Laboratory (ANL) operates a target development facility [1] that produces very thin targets used in atomic and nuclear physics experiments performed at the ATLAS (Argonne Tandem Linac Accelerator System) and Dynamitron accelerators. Targets are made not only for the Physics Division but for other divisions at the Laboratory and occasionally for other laboratories and universities.

2. Physics Division Target Laboratory

This facility prepares targets of various thicknesses and on substrates depending upon the request of the experimenter. Capabilities include apparatus for resistive heating and electron beam gun evaporation, sputter deposition and mechanical rolling of thin foils. Auxiliary equipment provides support for the numerous other activities required for target fabrication. These targets are produced from naturally occurring metals and compounds, radioactive materials and stable isotopes, which are supplied either in pure elemental form or as

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stable compounds. The latter sometimes entail sophisticated reduction techniques.

2.1 Vacuum evaporators

A. Electron beam gun

A Temescal Model ST1H-270-1, 8 kW, four-pocket source is used for electron beam evaporations [2]. This system provides the capability for deposition of high melting point material which could not be accomplished before. The rotating turret contains four crucibles and enables multiple evaporations to be performed. The E-gun is installed on a custom designed mounting and housed within an Argonne built high vacuum chamber pumped by an Air Products Model CSW-202 cryopump. The Kronos QM-331 film thickness monitor has been replaced with an Inficon XTM digital quartz crystal oscillator having also a deposition rate indicator. A Model QH-4000 substrate heater assembly and SCR power controller from the Eddy Co. has recently been purchased and needs to be installed.

This E-gun has been extensively modified by using an emitter developed at Florida State University. The four-pocket turret has been redesigned, mainly to assist cleaning and maintenance, but also to replace the 7 cc pockets with more shallow "dimple" shaped ones. This is an important consideration, for we mainly use only small quantities of isotopic material in the hearth. The electron emitter assembly has also been replaced with a new design using smaller filaments of .020" dia. tungsten wire. We can now wind our own filaments using routinely filaments with as few as 2 turns. These small filaments have had a dramatic effect on the beam spot size and hence deposition rates have increased substantially. Electron beam voltage, adjustable from 2 to 10 kV, was obtained using an Eratron EB-8 power supply produced by Innotec. The electron gun control module provides beam current adjustment as well as X-Y positioning of

the beam. Filament current may be monitored by a digital readout and is adjustable using an internal potentiometer. A second, identical control module is currently being retrofitted with a sweep circuit.

Many targets have been produced, using this system, which weren't possible in the past. They include self-supporting foils of $^{92,98}\text{Mo}$, yttrium and zirconium as thin as $100\text{ }\mu\text{g}/\text{cm}^2$ [3]. For molybdenum, carbon backings were also requested and were evaporated sequentially to produce the target. Other high-temperature materials evaporated using this gun include coatings of tungsten and chromium.

B. Veeco evaporator upgrade

The Veeco Model VE-775 vacuum evaporator is now using a CTI 6" cryopump and provides a cleaner and higher vacuum environment for target deposition. This cryopump, when operating, causes a vibration which can be felt in the baseplate. A vibration isolating coupler flange for the cryopump will be installed to reduce this vibration. The steel bell jar has been removed, replaced with a glass bell jar, and the hoist reattached to the implosion guard. A shutter has been installed as well as a high-current feedthru to be used with the quartz lamp substrate heater. Targets produced using this system include self-supporting foils of ^{121}Sb and ^{176}Yb , the latter also deposited on gold backings.

The Ion Tech Model Fab 11N focussed ion-beam sputter gun has been re-mounted within a feedthru ring. A good description of this source is given by Muggleton [4]. This modular approach allows for ease of installation when needed, freeing up the Veeco system for routine resistive heating reductions and evaporations.

C. Mortar source

This vertical electron beam source, manufactured by Veeco, GmbH, has been resurrected and installed within the NRC 3117 evaporator. It has been mainly employed for the high-temperature reduction of rare-earth isotopes to

produce metal targets. In a collaboration with P. Maier-Komor of TUM the power supply circuit was modified and some collecting techniques were explored. Reductions performed using this mortar source include Er, Gd and Nd. Targets of ^{148}Nd on stretched gold backings were prepared with this system.

2.2 Rolling of foils

We have in the past tended to procure rolled targets from ORNL [5] or Karasek [6]. With increasing demand for thick targets, it is advantageous to produce rolled foils in house, using a Frei & Borel type SE/EX rolling mill. Rolled targets of gadolinium have been prepared in number. A stacked target of rolled ^{156}Gd was recently supplied for a critical experiment at the BGO facility. We have set up a laminar flow clean bench with an anti-static workstation for the handling of these foils.

2.3 Alpha particle film thickness monitor

Due to problems sometimes encountered with deposited film thickness as measured using a quartz oscillator, an alternate means of measuring target thickness was desirable. A set-up was constructed within the target lab for using the energy loss of alpha particles to ascertain foil thickness [7]. Although dedicated to the target lab, the system is portable. Used in conjunction with multi-channel analyzer, energy loss measurements have been made using a ^{249}Cf source. An ADC board and software were purchased from NUCLEUS, Inc. for the IBM PC, which is now used to acquire and analyze the film thickness measurements. Energy loss tables specific to the target material are calculated using the Physics Division VAX computer. The intention is to fully automate this set-up in the future using a high-level computer language software routines.

An additional use for this system has been to test, document and archive ORTEC silicon particle detectors within the division. A good percentage of the detectors within the division have been tested and a database created of the results. These detectors were then employed in an experiment using a particle detector array at the BGO facility.

2.4 Target storage

The vacuum system for the computer controlled target storage chamber [8] was upgraded, replacing the rubber hoses with an all-metal system. A second, quite similar system has been constructed although not under active computer control. This system maintains chamber vacuum using a Varian V-200 turbo-pump. The addition of this 2nd storage system has allowed for much needed increased capacity and is used routinely for storage of foils which would oxidize if not under vacuum. Two desiccator cabinets were purchased for additional storage capacity beyond that needed for the vacuum desiccators.

2.5 Laboratory personal computer system

The IBM PC-XT computer system is now used extensively for a number of purposes. This computer has been upgraded with a new 40 Mb hard disk and addition RAM to bring it to memory capacity (640 kB). A math co-processor chip was installed to improve the speed of calculations. Significant software enhancements have also been provided including a current version of DOS, word processing, hard disk menu system, C compiler, etc.

Stored on this system are archives of previously requested targets which have been produced, dating back to 1978. These may be accessed by requestor, by target or isotope, by date, etc., and a report generated. Computer listings may be displayed or printed for inventories of all stable isotopes and chemical compounds maintained by the target development lab.

A communications port attached to the PHYLIS system allows for connections to the Physics Division VAX and to Argonne's central computing facilities. MS-KERMIT is used for file transfer and when graphics capabilities are desired. On BITNET our electronic mail address is "TARGETS@ANLPHY".

3. Radioactive Target Production Facility

Because of a need for low-level radioactive targets, a laboratory was assembled dedicated to the production of these foils. A Cooke evaporator system obtained from the Chemistry Division has been tested. It contains a quartz thickness monitor, shutter and thermocouple temperature sensor for process monitoring. All possible precautions have been taken regarding contamination. Containment is achieved using a glove bag and most interior surfaces have been shielded with aluminum foil, a technique employed to minimize radioactive contamination. Approval for the use of this set-up has been obtained from Health Physics.

Foils of ThF_4 have been prepared in this lab for a recent experiment at ATLAS. We were unable to purchase these foils when last attempted from outside suppliers. The ability to produce these foils here is an important new capability for the target lab. We anticipate a need for UF_4 targets as well and will begin preparing these in the near future.

A second much smaller evaporator system consisting of an 20 cm dia. bell jar and 5 cm dia. diffusion pump was constructed for close proximity evaporations of higher activity materials. The size of this system allows for minimization of contamination and can be installed within a hood.

These vacuum systems, along with the auxiliary equipment needed for target production are located in a separate lab which is dedicated for use with radioactive materials.

4. Research Plans and Future Objectives

Provide support for new initiatives within the Physics Division such as the FMA (Fragment Mass Analyzer) project and the APEX (Argonne Positron Experiment) proposal. Providing Tandem stripper foils as well as the new requirements for stripping and charge state selection from the PII (Positive Ion Injector) upgrade. Future target needs such as radioactive target development, rotating target wheels, etc. Research into new evaporation techniques such as laser beam evaporations and plasma assisted depositions. A mass isotope separator acquired from ANL Chemistry Division could be put into operation for the production of highly enriched targets.

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References

- [1] J.P. Greene and G.E. Thomas, Nucl. Instr. and Meth. A282 (1989) 191.
- [2] G.E. Thomas, J.P. Greene, R. Leonard and P. Maier-Komor, in preparation.
- [3] J.P. Greene and G.E. Thomas, in preparation.
- [4] A.H.F. Muggleton, Research School of Physical Sciences, The Australian National University (ANU-P/965 July 1987).
- [5] H.L. Adair and E.H. Kobisk, Proc. of 4th Ann. Int. Conf. of the Nuclear Target Development Society, Argonne National Laboratory, Argonne, IL, USA (ANL/PHY/MSD-76-1) 1.
- [6] F.J. Karasek, Nucl. Instr. and Meth. 102, (1972) 108.
- [7] D.M. Thompson, Proc. of 4th Ann. Int. Conf. of the Nuclear Target Development Society, Argonne National Laboratory, Argonne, IL, USA (ANL/PHY/MSD-76-1) 44.
- [8] G.W. Klimczak, B.G. Nardi and D.J. Travis, Nucl. Instr. and Meth. A257 (1987) 57.

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