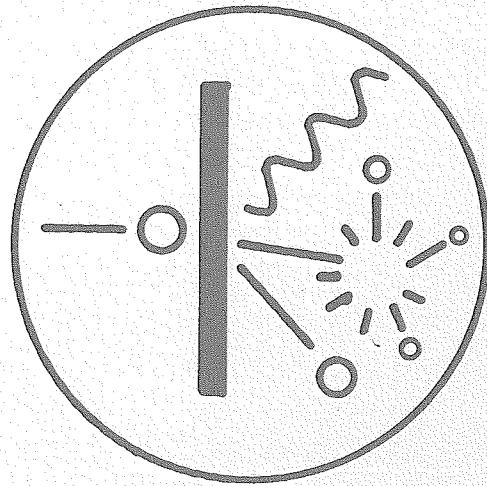


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INTERNATIONAL NUCLEAR
TARGET DEVELOPMENT
SOCIETY

NEWSLETTER



JULY 1979

INTDS Newsletter

July 1979

The Newsletter is distributed twice a year. It is intended to be a method of communicating information to both members of the society and those interested in target production.

Our response has been very good and we would in particular encourage all members to make a contribution each time as to what you are doing. It may provide useful information to other members of the society.

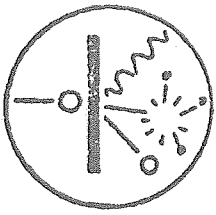
Editor

G. E. Thomas

Assembled and Typed by

Bonnie Kazich

Our thanks to the Physics Division at Argonne National Laboratory for their continuing support and encouragement in producing the Newsletter.



international nuclear target development society

June, 1979

Dear I.N.T.D.S. Members:

This letter is to inform you that our Society is officially registered as a non-profit, tax exempt corporation in the state of California. Our attorney has applied for federal tax exempt status, which we should receive by our next conference in Boston in October.

Our fiscal year has been changed to July 1st through June 30th due to incorporation. If the effective date on your membership card shows through Dec. 31, 1978, you are paid through June 30, 1979. Now is the time to renew your membership for 1979 - 1980. If you have not kept your membership current, I sincerely hope that you will take the opportunity to bring it up to date now. Your financial support is vitally needed so that the Society may carry out its present and projected activities aimed towards enhancing communications among and affording a proper forum for the recognition of researchers in our field and improving the status of the technology. Yearly dues are still only twenty dollars. Please send your dues by check or money order made payable to the International Nuclear Target Development Society to:

I.N.T.D.S.
c/o Ms. Joanne M. Heagney
197 - 34th Ave. E.
Seattle, WA 98112 (U.S.A.)

I look forward to hearing from you and receiving your renewed support for our Society.

Sincerely yours,

Joanne M. Heagney
Secretary-Treasurer

P.S. See you all in Boston in October.

F. J. KARASEK
MATERIALS SCIENCE DIVISION
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ARGONNE, ILLINOIS 60439, USA

Pressing of Melamine Targets

Several 100 mm × 150 mm × 150-160 mg/cm² target plates were required. Pressing of the melamine was accomplished by first blending a 5% melamine resin powder with melamine powder and adding water to form a very dry paste. The mixture was then air dried and pulverized to form a powder suitable for pressing. The required charge was loaded in the compacting die and pressed. (To prevent sticking, mylar film, 002" thick was placed between the melamine powder and die punch interfaces to afford easy removal). The pressed melamine target (with the mylar foil) was removed from the die and placed between two glass plates. This assembly "cured" for 24 hours at 60°C. The mylar facing foil was removed from the cured melamine prior to target mounting.

C. I. KRIEGER
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Coating Photomultiplier Tubes with P-Terphenyl

We have been coating the face of photomultiplier tubes with P-terphenyl to extend their sensitivity to visible light. It acts as a wave shifter from UV to visible light thus making a regular photomultiplier tube respond somewhat like one with a quartz window.

The coating is deposited by subliming it onto the face of the tube.

G. E. THOMAS
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Unusual targets produced this period include:

Target packets consisting of many foils mounted on thin Al (0.005") frames. For example, up to 40 C foils each $25 \mu\text{g}/\text{cm}^2$; 15 Al foils each $100 \mu\text{g}/\text{cm}^2$.

Standards produced:

25 and 50 mono-layers of Si on $50 \mu\text{g}/\text{cm}^2$ Al.
 5, 25 and 50 mono-layers of both B and Ti on $50 \mu\text{g}/\text{cm}^2$ Al.

Sandwich targets for heavy ion experiments:

C + Al + Ca + Ti, C + Si + Al.
 $^{120,122,124}\text{Sn}(0.5 \text{ mg}/\text{cm}^2) + \text{Al}(0.25 \text{ mg}/\text{cm}^2) + \text{Pb}(75 \text{ mg}/\text{cm}^2)$.

Also for heavy ion experiments:

$^{144,149,150,152,154}\text{Sm}(150-250 \mu\text{g}/\text{cm}^2)$ on 20 μgC backing.

Other interesting targets include:

Rh($125 \mu\text{g}/\text{cm}^2$) on quartz; Deuterated polyethylene ($50 \mu\text{g}/\text{cm}^2$) on 20 μgC ; Pt ($10 \text{ mg}/\text{cm}^2$); our evaporation and Frank Karasek's rolling produced $65 \mu\text{g}/\text{cm}^2$ ^{24}Mg .

We are continuing our efforts to design a system to produce many targets during one evaporation and transfer them under vacuum to a storage chamber.

MARIE-ANTOINETTE SAETTEL
 GROUPE DE SPECTROMETRIE NUCLEAIRE
 CENTRE DE RECHERCHES NUCLEAIRES
 67037 STRASBOURG CEDEX
 FRANCE

The following targets were prepared for nuclear physics experiments during the last months:

- ^{70}Ge , ^{74}Ge , ^{80}Se , $^{85}\text{RbCl}$ targets $120 \mu\text{g}/\text{cm}^2$ on thin carbon backings by direct heating of a tantalum boat.

- ^{31}P : 50 to $100 \mu\text{g}/\text{cm}^2$ thick on carbon backings with B. W. Hooton's method.

- self-supporting ^{10}B and ^{11}B targets, which gave me some problems. Finally, I used, with success, a similar method described by L. Csikas: Boron was evaporated with a 2000 Watts Varian electron-gun on a 0.2 mm thick Ni backing recovered with about $20 \mu\text{g}/\text{cm}^2$ NaCl and heated to 170°C . Self-supporting Boron targets, 40 to $100 \mu\text{g}/\text{cm}^2$, were obtained by this manner.

- $^{90}\text{ZrO}_2$: $100 \mu\text{g}/\text{cm}^2$ targets on thin carbon backings, by evaporation of the oxide with an electron-gun. However, the targets do not resist to the accelerator beam.

With H. J. Maier's technique, Fe_3^{13}C pellets of about 2g are produced by electron-gun melting (Fe: 94.6% - ^{13}C : 5.4%). The pellets are destined to a Hicomex Ion source and give a pure ^{13}C beam used at a M.P. accelerator.

The preparation of formvar films ($50 \rightarrow 100 \mu\text{g}/\text{cm}^2$) as entrance windows for heavy ion measurements is also a part of my activity.

ANDRÉE MÉENS

CENTRE DE RECHERCHES NUCLEAIRES

LABORATOIRE DE PHYSIQUE NUCLEAIRE ET DE PHYSIQUE APPLIQUEE

67037 STRASBOURG CEDEX

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Aside from usual targets, some work has been done on the fabrication of 1 and 2 μ ferro-magnetic isotopic Gd targets which will be used as backings. Gd_2O_3 has been reduced, distilled, rolled and annealed. The ferro-magnetism has been tested in the laboratory. A 1 mb/cm² ¹²²Sn layer was stuck by rolling onto the Gd foil and the two were then stuck again by rolling onto a 0.1 mm Pb foil.

We are also working on C strippers made by the cracking method but it is too early to give detailed results.

I would be glad if someone could give me some information on making self-supporting 1 mg/cm² Tl targets.

J. T. SLOBODIAN

THIN CARBON FOILS DEVELOPMENT DEPARTMENT

ATOMIC ENERGY OF CANADA LIMITED - COMMERCIAL PRODUCTS

P. O. BOX 6300

OTTAWA, CANADA K2A 3W3

Atomic Energy of Canada Limited - Commercial Products now have available Carbon-13 targets with a 99% enrichment. This new product on a 1" x 3" glass microscope slide will replace the 90% and 97% enriched targets previously offered.

J. L. GALLANT
 TARGET LABORATORY, NUCLEAR PHYSICS
 CHALK RIVER NUCLEAR LABORATORIES
 CHALK RIVER, ONTARIO
 CANADA, KOJ 1JO

Following the Munich Conference, the Chalk River Nuclear Target laboratory concentrated on three methods of stripper foil fabrication, namely: the foil slackening method (Harwell), the long-lived carbon stripper foils for heavy ion (Jaeri) and the high voltage cracked ethylene method (Daresbury).

With modification to these methods, several stripper foils were produced and tested.

This work will probably be presented as a paper, at the Boston Conference in October. It is hoped that another session will be devoted to this subject which might well prove to be the final words on stripper foils.

Carbon Foil Lifetime Measurements with ^{127}I Beams

Foil Type	No. of Foils	Average time to break foil in target chamber 0.1 μA at 10.5 MeV (min)	No. of Foils	Average time to 1/2 beam intensity with stripper foil in terminal $\sim 1 \mu\text{A}$ at 4.5 MeV (min)
AECL-CP	4	$3.3 \pm 0.8^*$	17	$1.5 \pm 0.4^*$
AECL-CP Slackened	7	70.5 ± 6.2	22	9.0 ± 0.8
JAERI	8	29.5 ± 4.9		----
JAERI Slackened	6	206.4 ± 35.3	24	25.4 ± 4.1
Cracked Ethylene	5	79.3 ± 24.1		----
Cracked Ethylene Slackened	3	296.6 ± 78.4	8	48.1 ± 20.2

*The uncertainties quoted are the internal errors of the mean.

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DEPARTMENT OF APPLIED PHYSICS
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Preparation of a Stepped Source Holder

Research by the nuclear measurements group at The City University is directed mainly at alpha particle stopping power measurements in liquids.

This has necessitated the production of a source holder consisting of a series of annular aluminum steps on a silver steel substrate with a good surface finish and of accurate uniformity and thickness.

The substrate was surface ground, lapped and polished and then cleaned ultrasonically and by ion bombardment to avoid flaking problems. Aluminum was then evaporated on to the substrate, in vacuo by feeding pure aluminum wire from a bar suspended above a tungsten filament, the bar being raised and lowered from outside the vacuum chamber by means of a handwheel. The steps were delineated by means of a number of aluminum masks, and the thickness of each step was monitored by a quartz crystal oscillator mounted alongside the substrate in the vacuum chamber.

The substrate assembly was fixed rigidly to a small platform which during evaporation was rotated at approximately 120 R.P.M. by a small electric motor. This overcame any tendency to uneven deposition due to geometrical factors. By this technique a series of steps varying from 1 to 10 μm within an accuracy of $\pm 4\%$ of the required thickness could be produced in a single evaporation.

D. W. L. TOLFREE
DARESBUY LABORATORY
SCIENCE RESEARCH COUNCIL
WARRINGTON WA4 4AD
ENGLAND

Carbon Stripper Foil Development Work at the Daresbury Laboratory

Since the last report in the Newsletter, further studies have been made on a number of different types of hydrocarbon-cracked carbon foils.

Comparative lifetime measurements on foils have been carried out using more damaging, 1.2 MeV Ar⁺ ions (DL/NUC/P92A). Foils were prepared as before by cracking Ethylene using a 90% Ethylene, 10% Argon gas mixture at a pressure of 0.05 Torr in a glow discharge. Carbon was deposited onto rock salt and evaporated sodium chloride on glass slides as substrates. The deposition was carried out at various voltages up to 4.5 kV on the cathode in a discharge tube. Foils prepared by the carbon arc process were used as standards. The glow discharge voltage was shown to be important since foils prepared at voltages below 2 kV disintegrated soon after bombardment by the argon ion beam whereas above 3 kV lifetimes averaged ~70 μ A minutes compared to 3 μ A minutes for standard foils. Most foils tested were prepared with voltages in the range 3 - 4 kV and lifetimes showed a slight increase at the higher voltages.

Hydrocarbon-cracked foils were slackened using a technique reported previously for standard foils (NIM 155, 565, 1978). The results showed that slackening improved lifetime by about a factor of 2 for the thicker foils. The improvement was not as great as the factor of 5 obtained by slackening standard foils probably because the shrinkage rate of hydrocarbon foils under irradiation is much less.

A wide distribution in lifetimes was obtained for all carbon foils. The reasons for this are being investigated. It means that before any reliable estimates of lifetimes can be made, large numbers of foils have to be tested.

A. MICHELSEN

FYSISCH LABORATORIUM DER RIJKSUNIVERSITEIT UTRECHT

PRINCETONPLEIN 4, UTRECHT

THE NETHERLANDS

Preparation of Red-Phosphorus Targets

The preparation of thick phosphorus targets by means of boat evaporation is a difficult process, which contaminates the evaporation unit.

Therefore, we prepared these targets with a heavy ion sputtering unit (Danfysik, Denmark). Lumps of red-phosphorus (purity 99,999%) are powdered in an argon atmosphere. The carbon crucible (see figure) is filled with the red-phosphorus powder. The powder is pressed into the hole in the middle of the crucible with a glass rod. This is done to prevent the material from jumping out during the sputtering process. The crucible and the substrate holder are put into the bell-jar. The distance between the middle of the crucible and the substrate is 15 mm.

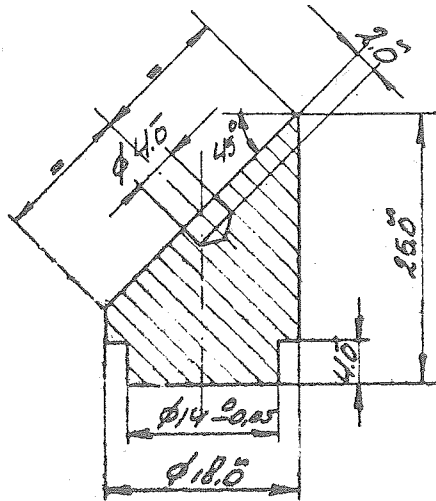
As substrates, gold foils with a thickness of 20-300 μm are used. The material to be sputtered is bombarded by an argon- or xenon-beam, delivered by a duoplasmatron ion source. In the case of a xenon beam, the sputtering process goes faster, but the process is more difficult to regulate than with an argon beam.

The prepared phosphorus targets had a thickness of 50 to 500 $\mu\text{g}/\text{cm}^2$. To obtain target thicknesses of the order of 500 $\mu\text{g}/\text{cm}^2$, it is necessary to fill the crucible three times with red-phosphorus. The thickness of the targets is measured by weighing them on a micro-balance. The accuracy is 1-2 $\mu\text{g}/\text{cm}^2$.

The advantages of this method over the boat evaporation method are:

1. High collection-efficiency of the sputtered phosphorus;
2. Very low contamination of the bell-jar after the sputtering process.

The targets prepared in this way have been used for the nuclear reactions $^{31}\text{P}(\alpha, n\gamma)^{34}\text{Cl}$ and $^{31}\text{P}(\alpha, p\gamma)^{34}\text{S}$.



A. H. BENNINK and T. W. TUINTJER

KERNFYSISCH VERSNELLER INSTITUUT

UNIVERSITY OF GRONINGEN

THE NETHERLANDS

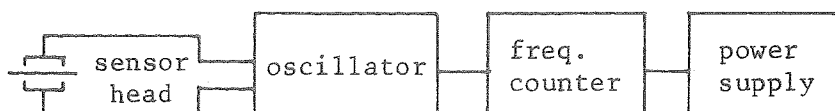
Some Brief Notes on Our Latest Activities:

1. A method has been developed for the conversion of isotopically enriched CeO_2 in Ce_2O_3 and the subsequent reduction of the Ce_2O_3 with efficiencies of 70-80% from the starting material.

2. Rare Earth oxides have been routinely reduced using a simple e-gun setup. Efficiencies of 80-90% are easily obtained. Clean, thin (20-200 $\mu g/cm$) carbon-backed Samarium targets have been produced in connection with a vacuum interlock and storage system.

3. Calcium targets have been produced in a way similar to that described by George Thomas (proceedings, 1975 conference), but using the same simple e-gun mentioned above.

4. A simple quartz crystal monitor at very low cost. Since the number of evaporators in our lab has increased considerably, we felt the need for another thickness monitor. A number of commercially available quartz crystal monitors were offered at prices which vary from Dfl 5.000.-- to Dfl. 8.000.-- (\$2.500.-- to \$4.000.--). We found, however, that all it takes to build a thickness monitor is a sensor head, an oscillator circuit and a frequency counter (see block diagram below).



The total cost for this unit is about \$200.--, while there is hardly any manpower involved. The first tests with the new unit seem to be very promising, so in awhile, we will be able to supply complete information to those who are interested.

5. Question - We have been working with a vacuum transfer and storage system for over a year now, but we have not been able to find a vacuum-tight, push-pull-rotary feedthrough for our system. Who out there is willing to help us?

A. H. BENNINK and T. W. TUINTJER

KERNFYSISCH VERSNELLEER INSTITUUT

UNIVERSITY OF GRONINGEN

THE NETHERLANDS

J. B. REYNOLDS

OLIVER LODGE LABORATORY

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P.O. BOX 147, LIVERPOOL L69 3BX

ENGLAND

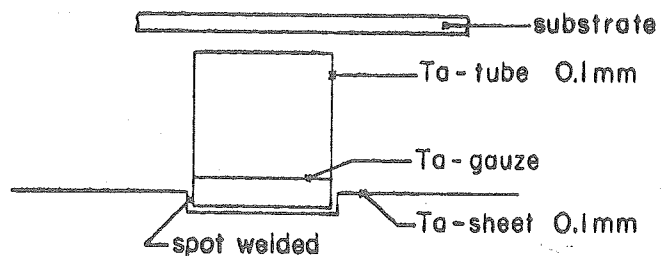
The Preparation of Thin ($\sim 200 \mu\text{g}/\text{cm}^2$) Sandwiched Selenium Targets

Since Selenium metal has a melting point of 217°C and vapor pressure of 10^{-7} torr, metallic Selenium targets deteriorate rapidly under beam bombardment.

The following technique was used for the fabrication of temperature resistant sandwiched targets of isotopically enriched Selenium. First, microscope slides, $76 \times 26 \text{ mm}$, were coated with a thin layer of CsI, to act as a release agent. A tungsten crucible was used for evaporating the first thin ($\sim 20 \mu\text{g}/\text{cm}^2$) aluminum layer onto the substrate. The substrate was then swung to a Ta-boat into which a carefully weighed amount of $500 \mu\text{g}$ of metallic Selenium was placed (Fig. 1). Inserted near the bottom of the tube is a piece of Tantalum gauze. The distance between the substrate and the tantalum-boat was kept to a minimum (1-2 mm) to get a nearly 100% recovery of the isotope. After this evaporation has been completed, the substrate holder was swung back over the tungsten crucible and a second thin ($\sim 20 \mu\text{g}/\text{cm}^2$) layer of aluminum was evaporated on top of the Selenium. The targets were then floated off in the normal manner and mounted in frames.

The targets of $^{76,78,80,82}\text{Se}$, produced by this method were exposed to a 45 MeV deuteron beam with intensity 100 nA for many hours with no sign of deterioration.

fig. 1
Cross-section of Source
Area 18mm diameter
20mm height

Resistance Heated

A. H. BENNINK and T. W. TUINTJER

KERNFYSISCH VERSNELLEER INSTITUUT

UNIVERSITY OF GRONINGEN

THE NETHERLANDS

An Electro-Chemical Method for the Reduction of Isotopically Enriched Cadmium Oxide, Zinc Oxide and Lead Nitrate

A simple electro-chemical method for the conversion of Cadmium oxide, Zinc oxide and Lead nitrate to the elementary form, similar to the technique described by Heagney¹, has been developed. The plating cell consists of a 140 mm long, 8 mm wide glass tube which is closed at one end. Near the same end, a 0.5 mm diameter Platinum wire is sealed in the glass tube, to act as a side anode (Fig. 1). This side anode is used to prevent the gas bubbles coming from the anode from damaging the crystalline Cadmium, Zinc or Lead, which is built up at the cathode. The cathode of this circuit is also a 0.5 mm diameter Platinum wire.

The plating solution for the Cadmium reduction was prepared by carefully dissolving 25 mg of Cadmium oxide, CdO, into 10 ml of concentrated (25%) ammonia solution, which was then poured into the plating cell. The current density was kept low, approximately 6 mA/cm², to avoid an amorphous building up of the metal. During the plating process, long "dendritic" crystals of Cadmium could be observed growing on the cathode which ultimately came loose and sunk into the bottom bulb of the cell.

After the plating process was completed, the solution was decanted and the metal recovered. The collected Cd was washed with distilled water and allowed to dry in a protecting Argon atmosphere. The metal obtained in this way was used to produce carbon packed Cadmium targets, using the method as described by Reynolds and Morgan².

The reduction of Zinc oxide is completely analogous; 20 mg of Zinc oxide, ZnO, was carefully dissolved into 8 ml concentrated (25%) ammonia solution. After the reduced metal was collected and washed, it was used to prepare carbon backed targets in much the same manner as described for Cadmium.

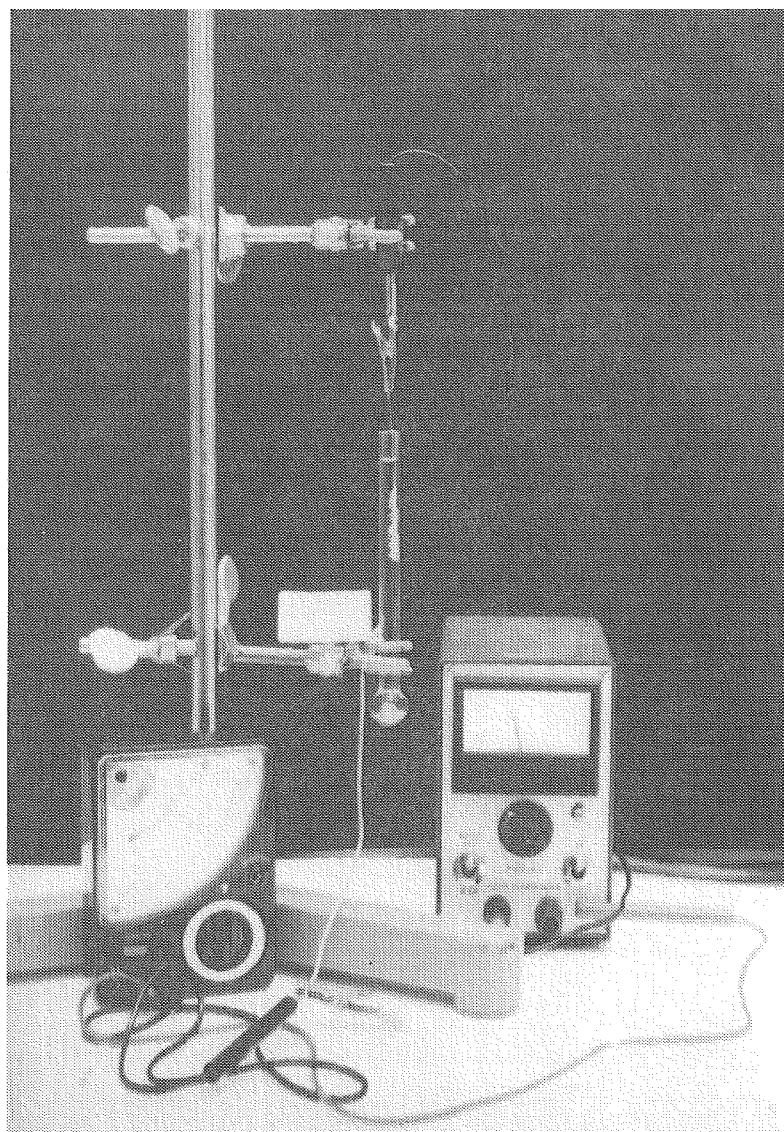
In general, the same technique as for Cadmium oxide and Zinc oxide was used to convert Lead nitrate into the element. The plating solution was prepared by dissolving 100 mg of $\text{Pb}(\text{NO}_3)_2$, into 10 ml of diluted (5%) formic acid. After the plating process the metal was washed, dried and evaporated onto formvar backings, to give clean self-supporting Lead targets³.

Using this technique, efficiencies of 75 -- 85% for both the Cadmium and the Zinc reduction and 60 -- 70% for the conversion of Lead nitrate have been routinely achieved with quantities ranging from 5 -- 100 mg of the starting material.

¹J. M. Heagney and J. S. Heagney, Proc. of the 1977 Conf. of the INTDS.

²J. B. Reynolds and T. L. Morgan, Proc. of the 1975 Conf. of the INTDS.

³A. H. Bennink, Nucl. Instr. and Meth. 146 (1977) 591.



H. L. ADAIR

ISOTOPE RESEARCH MATERIALS LABORATORY

SOLID STATE DIVISION

OAK RIDGE NATIONAL LABORATORY

OAK RIDGE, TENNESSEE 37830, USA

The Isotope Research Materials Laboratory (IRML) at the Oak Ridge National Laboratory (ORNL) has prepared 120 oxide disks (40 each of ^{238}U , ^{235}U and ^{237}Np) which will be used as neutron dosimeters. The disks are 1.27 cm diameter and 0.508 mm thick. Initially, attempts were made to vacuum hot press the disks; however, cracking problems made it necessary to choose an alternate procedure. The cracking problem was eliminated by vacuum hot pressing 1.27 cm diameter rods of the material and then cutting the disks with a diamond saw. This process has been used to cut disks as thin as 0.19 mm. The machined disks were double encapsulated in 0.13 mm copper by a diffusion bonding technique.

During the past two months, IRML has prepared approximately two grams of high purity ^{243}Am metal by reducing it from the oxide using thorium as the reductant. In previous distillations, the americium metal had been distilled directly into quartz domes. A chemical analysis of the metal indicated that the americium prepared in this manner was contaminated with silicon (500-1000 ppm). The silicon contamination apparently was due, in part, to the high temperature (1550-1650°C) necessary for the reduction and subsequent distillation of americium from the oxide. Thus, the ^{243}Am metal was prepared by first collecting the metal on tantalum and then redistilling the ^{243}Am metal from the tantalum. The latter process required a much lower temperature (1200-1250°C) and the resulting metal that was collected in a quartz dome contained ≤ 20 ppm silicon. The ^{243}Am metal collected by this double distillation process contained ≤ 300 ppm chemical impurities. Two foils 1 cm \times 1.2 cm and six 6.35 mm diameter foils approximately 0.05 mm thick were obtained.

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QUEENS UNIVERSITY
TARGET PREPARATION LABORATORY
KINGSTON, ONTARIO, CANADA

Some Observations on the Electrodeposition of Films for Nuclear Targets

The increasing interest in electroplating as a method for producing thin film targets prompts me to offer some of my observations on the subject.

One of the problems often encountered is that of rough or dark deposits. The electroplater has, since the 1920's been using "magic" to combat these dark or matte films. They are the result of rough deposits caused partly by high current densities and/or dendritic growth of crystals, and the effect is exponential.

Because these solutions are operated with metal contents below that of recommended plating formulae, we cannot take the usual steps to prevent matte films, such as adding "brighteners" as they are known in the trade. Neither can we adjust the current density until the desired result is obtained as these unconventional baths often do not deposit at all at low current densities, because then the solubility of the deposit exceeds the formation rate. As late as the 1950's addition agents such as liquorice, glue and corn syrup were used, and detergents are commonly used to reduce surface tension. Some of these plus chemicals used for pH adjustment would definitely introduce undesirable contaminants in the case of plated targets.

When developing a solution for electroplating films for targets, the target maker should start by dissolving the element or compound in as small amount as possible of acid (or alkali) in which the material is soluble, avoiding Nitric Acid if possible; if not, the NO_x can be driven off later with heating. If the pH needs raising to decrease the solubility of the film in the solution, Ammonium Hydroxide may be added after water dilution making a suitable adjustment for the final volume, which seldom exceeds 50 ml. The anode is invariably Platinum, and current should always be switched on before the substrate

is immersed. If spring or alligator clips are used to suspend electrodes, they should be first gold plated and preferably not allowed in the solution. It is useful to have on hand a copy of the Metal Finishing Guidebook.

A typical bath used at Queens University to produce ^{64}Zn , ^{66}Zn , ^{68}Zn targets is given below. If the isotope is in the form of metal, it is dissolved in the H_2SO_4 but if in the Oxide, it is dissolved in dilute Acetic Acid and the Sulphuric Acid added.

30 mg. Zn
2 ml. H_2SO_4
1 ml. Acetic acid
10 ml. NH_3OH
24 ml. Distilled water
Current density 0.5 amp/cm^2

The Metal Finishing Guidebook is published by:

Metal & Plastics Publications
1 University Plaza
Hackensack, NJ 07601 (U.S.A.)
Price: \$5.95 (\$1 postage)

U. SANDER, H. H. BUKOW and H. V. BUTTLAR

INSTITUT FÜR EXPERIMENTALPHYSIK III

RUHR-UNIVERSITÄT BOCHUM

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WEST GERMANY

Lifetime of Carbon Foils Under Fast Ion Irradiation

At the 5th International Conference on Beam-Foil Spectroscopy¹, we reported that the energy dose leading to foil destruction is $D_{\tau} = (2.3 \pm 0.4) 10^{15}$ keV/ μg for 100 keV $^4\text{He}^+$ ions. In between, we have studied the influence of energy, current density and foil surface density on the lethal dose D_{τ} . The dose does not depend on the energy in the range from 80 keV to 311 keV for $^4\text{He}^+$ and from 200 keV and 300 keV in the case of $^7\text{Li}^+$ as projectiles (see Fig. 1). In these experiments, the ion current density was varied between 80 $\mu\text{A}/\text{cm}^2$ and 350 $\mu\text{A}/\text{cm}^2$. No significant variation of the lethal dose with the ion current density could be observed. The surface density was varied between 5 $\mu\text{g}/\text{cm}^2$ and 50 $\mu\text{g}/\text{cm}^2$. Up to 20 $\mu\text{g}/\text{cm}^2$, the dose is constant. For thicker foils, the lethal dose is slightly reduced. As an improved value of the lethal dose we propose $D_{\tau} = (2.11 \pm 0.36) 10^{15}$ keV/ μg .

¹Journal de Physique C1, 301 (1979).

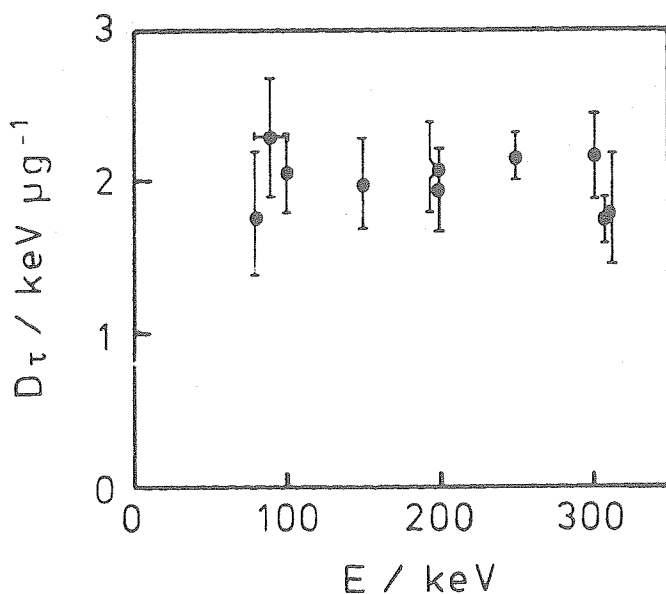


Figure 1. Lethal dose (D_{τ} is to multiply with 10^{15}) as a function of the ion energy. Each point results from 10 to 20 measurements.

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TANASHI-CITY
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In Japan we now have eight cyclotrons, four Tandem accelerators and four Van de Graaffs, so there is a big demand for various targets. Most of the targets are prepared by graduate students and researchers when they need them, and professional target makers are very few. In some cases, we purchase ready-made targets from Oak Ridge National Laboratory in the United States.

Table I shows techniques used generally for target preparation in Japan. In the left column of the Table, most of the techniques described are well known and widely used. The column in the extreme right shows the number of institutions which have the facilities for those techniques. The equipment for the vacuum evaporation method is commercially made and used in many institutions. As far as we know, all the commercial ones were purchased from domestic manufactures, none from abroad.

TABLE I. TECHNIQUES USED FOR TARGET PREPARATION IN JAPAN.

Technique	Field of Application	Thickness	Examples of Targets	Number of Institutions
Electroplating	Metal or Metal Oxide	0.3 to 15 mg/cm ²	Cu, Zn, Ni, Sn, etc	6(home made)
Electrophoresis	Powdered Material	0.5 to 10 mg/cm ²	CaCO ₃ , La ₂ O ₃ , etc.	3(home made)
Ultracentrifuge	Organic Backing	~10 µg/cm ² and up	VYNS	3(home made)
Thermal Cracking	Target of ¹² C Backing of ¹² C	0.2 to 4 mg/cm ²	C, Si, etc	5(home made)
Centrifugal Settling	Thin Targets Thick	0.1 to 50 mg/cm ²	Al ₂ O ₃ , GeO ₂ , PbCO ₃ , Sm ₂ O ₃ , etc	7(home made)
Rolling	Metal	300 to 700 µg/cm ²	Pb, Mo, Sn, Fe, etc	8(home made)
Evaporation				
a. resistance heating	Low Melting Material	0 to 3 mg/cm ²	Y, Sn, Au, Cu, Ca, etc	24(commercial)
b. electrobombardment	High Melting Material	0 to 5 mg/cm ²	Be, B, Mo, Si, etc	4(commercial) 4(home made)
Focussed Sputtering	High Melting Material	0 to 300 µg/cm ²	Nb, Zr, Au, etc	2(commercial) 1(home made)
Ion Beam Retardation	Small Quantities of Metals	0 to 100 µg/cm ²	Si on Thin Al Foil Li on Thin Au Foil	1

R. J. LEITE

T R W, 01/1010

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The past seven years, I have been associated with laser fusion target fabrication first at KMS Fusion, Inc., Ann Arbor, Michigan and now here at TRW Systems for the last eighteen months. In February, we were one of six industrial firms awarded a DOE contract to examine engineering technologies related to the design and construction of a prototype fusion power reactor upon satisfactory completion of the on-going scientific experiments.

Two of the four tasks included in our contract involve laser fusion targets. One concerns the methodology of mass production of targets and the second concerns the cyclic injection of these targets into the reactor central chamber. I am responsible for the former task and will heavily support the second.

Initially, we plan to assemble a catalog of fabrication processes and techniques which can be continuously updated as the art matures. This will include materials compatibility. The catalog may be divided according to the type of driver, namely, laser, electron, positive ion, negative ion, or neutral particle beam since each driver requires a different target configuration.

A typical reactor may require 10^5 to 10^6 targets per day, each requiring some dimensional accuracies of tens of angstroms. This may provide some idea of the enormity of the problems to be confronted in developing these systems. We will need to consider every target development trick available before this program is concluded, possibly ten years from now. Hopefully, the INTDS membership will provide some recommendations from its vast store of knowledge and experience.

L. SAPIR

DEPARTMENT OF NUCLEAR PHYSICS

THE WEIZMANN INSTITUTE OF SCIENCE

REHOVOT, ISRAEL

As a member of the International Nuclear Target Development Society, I would like to suggest an international exchange program of target technicians. This will enable each technician to further his knowledge and experience at the various different institutions. Since, there is only one technician in each target laboratory, this exchange will not leave the lab without a technician and still allow him to further develop himself.

If as a target technician you are interested in joining such an exchange, please contact the International Nuclear Target Development Society.

E. B. FEHR

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Recently, there has been a demand in our group for thick films ($5\text{-}120\text{ mg/cm}^2$). One of our graduate students has developed methods for preparation and measurement of very uniform thickness films in this range and plans to present a paper on this at the Boston Meeting.

David Radford has found a convenient method for Bismuth films ($20\text{-}50\text{ mg/cm}^2$) as follows:

Stretch a piece of aluminum foil (kitchen foil, dull side down) over a shielding cylinder with a small opening for observation of temperature ($\sim 600^\circ\text{C}$ at 10^{-5} Torr). Place appropriate amount of Bismuth shot into open tantalum boat and evaporate slowly (less than $1/2\text{ mg/minute}$). Cut aluminum into desired width strips. The bismuth foil peels off easily.

