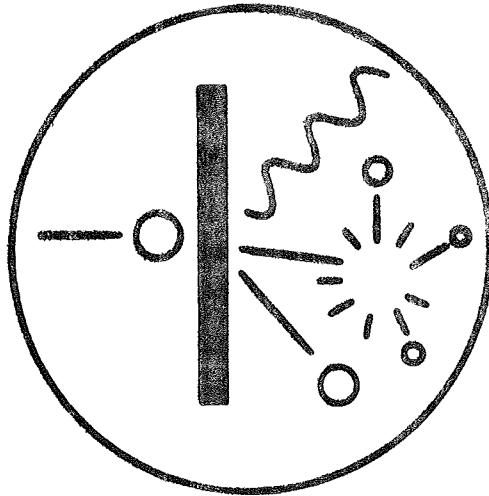


**INTERNATIONAL NUCLEAR
TARGET DEVELOPMENT SOCIETY**

NEWSLETTER



APRIL 1981

INTDS Newsletter

April 1981

We are putting out the first issue of the INTDS Newsletter this year. The response for contributions has been much appreciated. We would further encourage all members to make contributions. The following items could be of interest :

1. Description of recent work.
2. Information of any newly developed technique or progress made.
3. Request for advice on, for example :
 - making specific targets
 - obtaining specific material
(e.a. enriched isotopes)

Our thanks are due to the Direction of the Central Bureau for Nuclear Measurements for their support in producing the Newsletter.

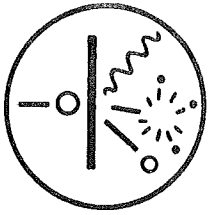
Editor :

Jan VAN AUDENHOVE
Central Bureau for Nuclear Measurements
B - 2440 GEEL (Belgium)

1980 WORLD CONFERENCE

international nuclear target
development society

March 16, 1981



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Dr. James S. Kane, ER-10
Associate Director for Energy Research
Office of Basic Energy Sciences
Department of Energy
Washington, D.C. 20545

Dear Dr. Kane:

As President of the International Nuclear Target Development Society I wish to advise you of the Society's unanimous concern regarding the rapidly disappearing stocks of separated isotopes which have been historically available from the DOE through Oak Ridge National Laboratory (ORNL). Diminution of these important isotopes is effecting a serious decline in the feasibility and accuracy of nuclear experiments and in the frequency of their use for other engineering, medical and scientific studies. In addition, the preparation of targets for nuclear medicine applications is being deleteriously affected by the reduced availability of pertinent isotopes. It would seem incongruent with the energy and scientific policies of the DOE and of the United States in general that such valuable resources are being purposely limited by insufficient funding of the calutron (electromagnetic) separative facilities at ORNL.

The only other source of separated isotopes, in any meaningful quantity, is the U.S.S.R. This alternate source is of limited utility since, in most cases, the assay and purity of their isotopes is insufficient and their general availability is marginal and jeopardized by political unrest. Furthermore, the availability of separated heavy element isotopes (thorium, uranium, plutonium) from the Russians is nil. Again, it would seem that forcing the international technical community to use this source of isotopes is contrary to the interests of the United States.

As producers of accelerator targets, dosimetry materials, standards, safeguards materials, and myriad other isotope forms for research, development, medical, and engineering applications, we of the INTDS feel strongly that the present status of isotope inventories in the United States and their attenuated availability is an intolerable condition. This is especially true when

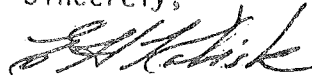
Dr. James S. Kane

March 16, 1981

considering that many applications requiring isotopes are being funded directly or indirectly by federal financing. Rectification of the present condition must be accomplished through increased funding for the calutrons at the earliest possible time, the cost of which can be recouped through future sales of these valuable materials.

At the forthcoming 10th World Conference of the INTDS in October 1981 (Kiryat Anavim, Israel) I would like to present to our membership your position with respect to this major problem. I would appreciate your cooperation in considering this matter and look forward to your reply. If you wish any further documentation of the needs for isotope materials, I would be pleased to furnish them to you.

Sincerely,



E. H. Kobisk, President
International Nuclear Target
Development Society

EHK:cet

Progress Towards Understanding the Structure and
Irradiation Characteristics of Glow Discharge Carbon Foils

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Since the first beam lifetime measurements were made on carbon foils prepared by the cracking of ethylene in a glow discharge [1,2] work has been directed at understanding foil structure and behaviour under heavy ion bombardment. The enhancement in lifetime obtainable with these foils is mainly due to their slower shrinkage rate compared with evaporated foils. It is therefore important to establish the relationship between this and foil structure.

Optical absorption measurements have been made at normal and non-normal incidence in the range 1.5-5.5 eV on a number of self supporting foils prepared by electron beam evaporation and DC glow discharge. Preliminary results show evidence of partial alignment of aromatic or trigonal layers perpendicular to the surface in glow discharge foils but not in electron beam evaporated foils. A limited number of observations made on irradiated foils support our earlier results from electron beam diffraction studies [3] that 3D graphitisation with the appropriate trigonal layer spacing develops during irradiation. If the layers are already partially aligned normal to the surface this would account for the small amount of shrinkage observed to be necessary in the plane of the foil in order to accommodate the changes. (The layer spacing of 3.6 Å is large compared with 1.4 Å spacing within the layer).

Foil lifetime has been shown to depend upon deposition conditions such as ion energy (DC bias voltage), gas mixture and substrate temperature [4]. The optical absorption curve shifts to lower energies with increase in ion energy during deposition. This shift is seen as the DC bias voltage is increased and also as argon gas is added to the ethylene, the argon ions increase the bombardment of the carbon layers during deposition. Below a bias voltage of 1.5 KV the structure of the carbon foils does not sustain heavy ion bombardment, foils break immediately on exposure to a beam. The optical absorption technique can therefore provide a useful non-structive method of examining foil structure in relation to certain deposition parameters.

In a clean vacuum environment it is found that under irradiation glow discharge foils become thinner as a result of sputtering processes.

Measurements have been made using a 1.6 MeV deuteron beam (10 μm x 10 μm) as a probe of the change in areal density of foils that had been irradiated for different times by a 1.2 MeV Ar beam [4]. The consequence of this to the use of such foils as strippers in a tandem accelerator has been examined with respect to energy loss straggling and multiple scattering. Except for ions ($Z > 53$) the non-uniformities of these foils do not significantly reduce beam quality.

It should be noted however that beam energy spread will probably be time dependent as the foil is sputtered away.

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1. A New Long Lived Carbon Stripper Foil
NIM 159 (1979) 605-606.
2. Irradiation Lifetimes of Carbon Stripper Foils made by Cracking Ethylene in a Glow Discharge
NIM 166 (1979) 333-337.
3. Electron Diffraction Studies of Carbon Stripper Foils
Phys. Mag. A 1980 Vol. 42 No.2 217-265.
4. The Lifetime Under Irradiation of Carbon Stripper Foils made by Cracking Hydrocarbons
NIM 163 (1979) 277-278.
5. The Uniformity of Carbon Stripper Foils
DL/NUC/P.127A.

Footnote

I would be glad to know of people who have used the plasma glow discharge technique to produce targets or who are interested in doing so.

A range of carbon targets can be made from the cracking of hydrocarbon gases, for example C^{14} from acetylene, and silicon targets from cracking silane, the latter technique has been used successfully in the manufacture of silicon solar cells.

This technique of producing films by the decomposition of gases in a plasma offers the possibility of producing targets with unique properties which may be controllable. Because electrons in the plasma possess sufficient high energies to break molecular bonds, chemical processes can occur at relatively low temperatures.

There is obviously scope here for research and development.

The Not-So-Elusive Diamond Foil

John O. Stoner, Jr.

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At the Annual Meeting of the International Nuclear Target Development Society in Boston, 1-3 October 1979, P. Maier-Komor repeated a previous suggestion that diamond foils might have long lives when used as strippers, and that it would be interesting to test them even if they did not have long lives. It now appears that diamond foils have been tested by several groups to date, without realizing what they were testing. In fact, there is substantial evidence that foils made by high-voltage cracking of hydrocarbon gases do have structures and mechanical properties approaching those of diamond.

This evidence was made available to me by H. A. Macleod (1). The optical-coating community has been working for many years toward making rugged tenacious, transparent films having high refractive index. During the past ten years several papers have appeared which describe properties of such films. Their deposition requires bombardment of the growing film by energetic positive ions, either carbon ions or other ions (2, 3, 4), sometimes in a glow discharge (5, 6). The layers have a refractive index close to that of diamond (7, 8) and are very hard (2, 4, 5). The layers are essentially pure carbon and have mean atomic spacings similar to those in diamond (2, 3, 9). In addition they are non-conducting (2, 3, 6, 8).

It would appear that there is substantial reason to believe that the cracked-ethylene foils in current use are in fact diamond-like in structure and composition.

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- (2) S. Aisenberg and R. Chabot, J. Appl. Phys. 42, 2953-2958 (1971), and J. Vac. Sci. Technol. 10, 104-107.
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K.O. Zell

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1. Rolling of Bi

The material which we have is hard and brittle. We found out that it becomes ductile if one melts it on a stainless steel sheet over a bunsen burner and lets the drop fall on a second cold steel sheet where it becomes flat and is cooled very rapidly. We rolled it down to 8 mg/cm^2 and it should be easy to make it thinner.

2. Rolling of Te

We distributed the isotopically enriched Te powder, which we obtained from Oak Ridge, in the thinnest layer, which one can make without visible holes, on a polished stainless steel sheet. We put a second steel sheet on top and heated both sides some seconds with the blue flame of a bunsen burner. The hot sheets were rolled with slight pressure only one time. We obtained metallic looking pieces of about $15 \times 10 \text{ mm}$. The minimal thickness was 4 mg/cm^2 and depending on the grain of the powder.

3. C-Te-C sandwiches

$100 \text{ } \mu\text{g/cm}^2$ Te targets on $10 \text{ } \mu\text{g/cm}^2$ C were used in an α -beam of 200 nA. After some hours the Te was evaporated at the $1 \times 1 \text{ mm}$ beam spot. A sandwich target of $5 \text{ } \mu\text{g/cm}^2$ C + $100 \text{ } \mu\text{g/cm}^2$ Te + $5 \text{ } \mu\text{g/cm}^2$ C proved to be stable. Both C layers were made by ethylen cracking.

4. Other activities

The following targets were obtained by rolling:

Bi 8 mg/cm^2 (same method as Te), Hf 50 mg/cm^2 (single crystal material), Zr 1.7 mg/cm^2 (single crystal material), Pd 1 mg/cm^2 , Sm 0.5 mg/cm^2 , Nd 0.5 mg/cm^2 , Cd 3 mg/cm^2 (powder obtained by electrolysis from CdO pressed and rolled, not molten).

Cd 0.5 mg/cm^2 was evaporated on 2 mg/cm^2 Au for plunger targets with the same method as described for Zn ¹.

¹K.O. Zell, A. Dewald, A. Geuer: INTDS Newsletter,
Feb 1980, 12

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Nuclear Target Making and Development

The Physics Division has a facility which produces very thin targets for experiments at the tandem and dynamitron accelerators, for experiments of other members of the Division, any other division at the Laboratory needing this service, and occasionally for other laboratories and universities.

This year at the facility we produced targets varying in thickness from a monolayer to several mg/cm^2 . The different elements, isotopes or compounds evaporated, rolled, anodized or oxidized included Al, AgCl, Al_2O_3 , nat,10,11_B, ^{209}Bi , BaCl_2 , Be, C, nat,40,48_{Ca}, ^{116}Cd , CaF_2 , Fe, Formvar, FeS, ^{76}Ge , nat,6,7_{LiF}, $^{24,26}\text{Mg}$, melamine, NaCl, nat,58,60,64_{Ni}, Nb, $^{15}\text{NH}_4\text{NO}_3$, nat,208_{Pb}, ^{121}Sb , nat,28,30_{Si}, nat,144,150,152,154_{Sm}, nat,116,118,120,124_{Sn}, nat,124,128,130_{Te}, Ti, TiO_2 , ^{48}Ti , Ta, ^{182}W , ^{92}Zr , and ^{170}Yb . Ti, Nb, and B standards consisting of 5, 25, and 50 monolayers deposited on $50 \mu\text{g}/\text{cm}^2$ Al were also produced.

New techniques were developed to produce multilayered targets used for heavy-ion experiments. These are quite different targets from those used in the past and often time consuming to produce. A technique was developed by B. Zeidman and F. Karasek (MSD) to produce large area boron targets for medium-energy experiments,

The target fabrication program to produce better targets with higher purity is continuing. A split tube furnace is now in use and we are routinely reducing our separate isotopes to metallic form. Others in the Division are also using this facility.

Plans for the future include the completion of our third evaporation system, making our target-making laboratory more useful for other programs, fabrication of our multitarget evaporation system and new systems to improve the quality of our targets.

Welding $10 \mu\text{g}/\text{cm}^2$ Ta Foil Vacuum Tight

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An experiment requiring liquid Cd in the beam was accomplished by welding the Cd into a vacuum tight Ta envelope. An all Cu welding tool was developed for this purpose and is shown in the drawing. The handle can be made in any variety of ways from materials that are suitable conductors. The welding wheel and its retaining pin are best made of oxygen free Cu and should have a large contact area for optimal thermal and electrical conductivity. The wheel itself should be as large as is practical. Its periphery should be turned and polished until it has a radius equal to its thickness, 1-1/2 to 2 mm for light foil 3 mm for heavy Ta.

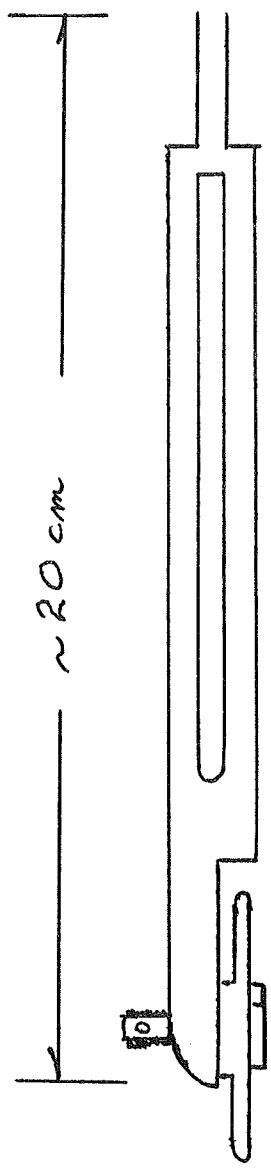
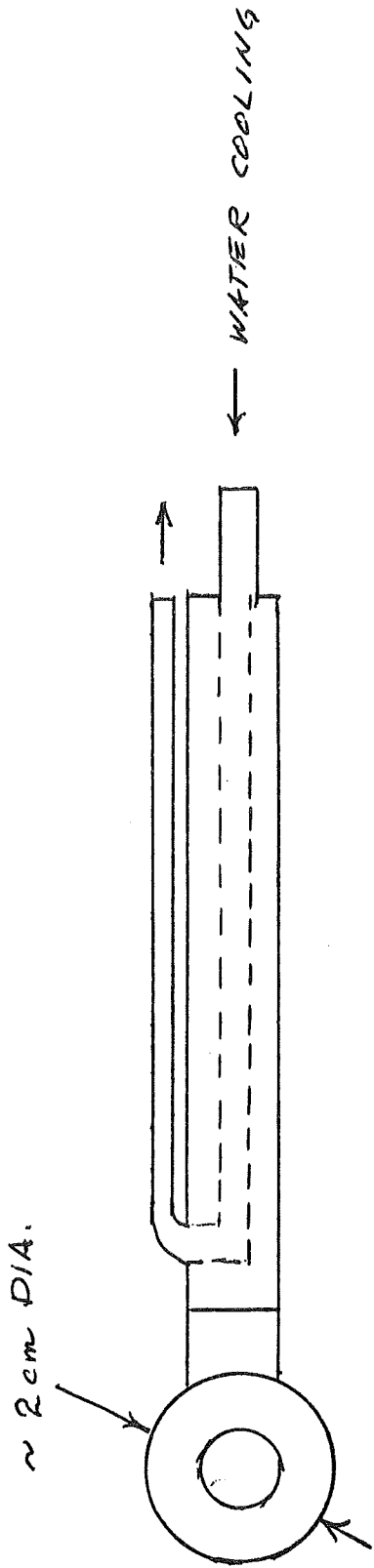
In practice Ta is rolled to $10 \text{ mgs}/\text{cm}^2$ for the most reliable package. Thinner foils have been accomplished but they are difficult to keep flat during the welding operation and will leak where minute creases develop. This, besides pin holes, is the major cause of failure in foils of $5 \mu\text{g}/\text{cm}^2$ and less. Next Cd is rolled as thin as possible and still fit inside the envelopes which were $\sim 2 \times 3$ cm. The three pieces are stacked on a heavy polished plate which is connected to the secondary of an evaporator's power transformer in series with an ammeter. The

handle is connected to the other tap in series with a foot switch. The welding current is adjusted, with an auto transformer in the primary side, using a test piece of Ta, to 50 amps at 3 volts.

Place the roller on one corner of the envelope, turn on the current and roll slowly along the edge. Use only moderate pressure, as though writing heavily. Turn the power off at the end of the pass. Multiple passes on the same edge are not necessary. Complete the remaining three edges the same way. The wheel must never be brought to or from the work with the power on. This causes arcs which punch holes in thin Ta and pits in the wheel requiring that it be repolished. Never allow the Ta to become so hot that it glows red under the wheel; this oxidizes and ruins welds. To remedy this, move the wheel more rapidly or lower the current.

Not having a vacuum box available, the envelopes were welded under Ar, weighed, heated via a Ta ribbon to twice the melting point of Cd, and held under vacuum for over 48 hours with no detectable weight loss.

With some more current the unit works very well for 0.005" Ta and all manner of boats, crucibles, heaters and shields can be fabricated. Notice the small hole shown in the end of the wheel's retaining pin. A small Cu rod can be inserted there for use when spot welding. It is retained with a second nut on the pin.



ROLLER WELDING HANDLE

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Activities during the last six months

- 1) A productive visit to the target laboratory at the Niels Bohr Institute (Denmark) where some sputtering problems were resolved with the help of Geirr Sletten and Jette Sørensen.
- 2) Sputtering of Pt, Ge, Mo, W, Hf, Ti and others using a fine beam Saddle Field Ion Source (A) and the Danfysik (B) sputter unit. Good films, including self supporting, were obtained from both systems and some early observations are listed.

	A	B
1.	Small Ion Source 57 mm x 86 mm	Rather large and heavy
2.	Variable positions for Ion Source (or Sources)	Fixed Ion Source
3.	Uniform Beam 1.5 mm θ	Variable focus Beam
4.	No Filament	Hot Filament
5.	Possible contamination from Ion Source	No contamination from Ion Source
6.	Shorts occur because of internal flaking and clean up can take up to 3 hrs	Usually filament failure clean up time up to 1 hr.
7.	Relatively inexpensive	-

Further development proceeding.

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March 9, 1981

Recent targets developed by me for purposes of fusion studies at Massachusetts Institute of Technology were made by resistance heating with boats of different materials and design unless designated (E-gun).

Self supported - Pd¹¹⁰ (~200μg/cm²), Tm(300-500μg/cm²)
Sm¹⁴⁴ (300-400μg/cm²), Zr⁹⁰O (200-300μg/cm²),
Ag¹⁰⁷ (100-200μg/cm²), Ni^{58-²60-62-64} (200-300μg/cm²),
Ta(400-600μg/cm²) (E-gun), Nb(60-80μg/cm²).

Look forward to seeing you in Israel.

Sincerely yours,



A. Luongo

AL:JH

ISAO SUGAI

Institute for Nuclear Study
University of Tokyo
Midori-cho, Tanashi-shi
TOKYO, Japan

Yb and Sm targets ($300-500\mu\text{g}/\text{cm}^2$ in thickness) of rare earth elements were made at first from Sm_2O_3 and Yb_2O_3 powder by reauaction evaporation with Al metal pieces and then repeatedly rolled. ^{24}Mg and ^{26}Mg self-supporting targets ($100-300\mu\text{g}/\text{cm}^2$ in thickness) of high purity have been made. The use of reactive target materials such as Sr, Ba, Li, Na and Ca has several trouble in preparation, transportation and storing in air. To solve these problems we have developed handling systems, target transfer containers and a glove box to make such reactive target. A heavy ion sputtering apparatus for preparation of thin self-supporting targets or backed targets with thin carbon fiol has been designed in our institute in 1979. It has been almost completed in this year. The sputtering apparatus is basically based on the design by Sletten and Knudsen. However, we have some modification in following points: the dimensions of the ion source, the focusing elements and in the details of other components. Accessories are attached enabling to estimate the thickness of material deposited during evaporation process and coat the substrate plate with such release agents as NaCl and CsI without breaking the Vacuum. Typical operating conditions and characteristics of the system are given in table 1. We are under development of the targets of W, Pd and Zr materials with the system.

Typical running parameters

ion species	Ar ⁺
ion current	1-2.5 mA
Source gas	Argon 99.99 o/o impurity
Vacuum gauge reading	(1x10 ⁻⁵ Torr)
Filament current	40-50A
Arc current	2-3A
Extraction voltage	15 KV
Focus Voltage	1.2 KV
Beam spots	2-4 mm ϕ

I would be very glad if someone could give me some information on making self-supporting Hf targets ($\sim 500\mu\text{g}/\text{cm}^2$ from HfO_2), Sr targets ($\sim 500\mu\text{g}$, from $\text{Sr}(\text{NO}_3)_2$) and Si targets ($\sim 300\mu\text{g}/\text{cm}^2$, from SiO_2) with low oxide content. Especially, I want to know the preparation method of Si target ($\sim 300\mu\text{g}/\text{cm}^2$ in thickness) at least 5% below in oxide content.

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Two different, yet related, areas have been investigated recently. One area has been the fabrication of multi-layer targets; the second, the gold-plating of alumina plates for use in the making of hybrid circuits.

Although the use to which the final product was put was very different, we encountered the same problem of adherence in the both cases. Possibly these adherence problems are well-known to thin films specialists, but seem not especially so to the target makers. This is the reason why we feel it useful to summarize here some of the things we have learned empirically about the subject.

The essential condition for a good sticking is the perfect cleanliness of the substrate. The slightest trace of grease will have deleterious effects. In general the following procedure has been found to work well:

- Wash the substrate successively with the solvents acetone, trichloroethylene, then methanol.
- Outgas the substrate in vacuum at around 300 °C
- Subject the substrate to a glow discharge.
- Outgas the material to be evaporated just below its melting point before the substrate is placed in the evaporator.

While the quality of vacuum is important, we found we could get satisfactory results with a diffusion pump.

One must also consider that not all substances stick well to every substrate. In the case of two incompatible materials, a thin go-between layer of a third substance is necessary.

We have successfully realized the following three types of constructions. The first two were targets used for accelerator experiments, while the third served as substrates for hybrid circuits.

I. One type of target was composed of the layers (in order):

- a. V_2O_3 of 200 $\mu\text{g}/\text{cm}^2$
- b. Cu or Ag of 0.8 to 1 μ
- c. Ni or Fe of 0.2 to 1 μ
- d. A. or Pd or Fe of 1 μ

The procedure followed was to roll the film needing the best

thickness accuracy, usually the layer (b) or (c), then the evaporation of the layer (b) and (d) or (c) and (d) is made, followed finally by the evaporation of V_2O_3 .

II. The other kind of target was composed of (again in order);

C of 150 to 200 $\mu\text{g}/\text{cm}^2$
Au of 40 $\mu\text{g}/\text{cm}^2$
Gd of 3 to 4 μ
Au of 0.6 to 1.5 mg/cm^2

The rolled and annealed Gd foil was the starting point of this target. For the experiment, the Gd had to be ferromagnetic (see Preparation and Testing of Ferromagnetic Fe, Co, and Gd Foils, Proceeding of the INTDS Meeting, Boston, 1979). The 40 $\mu\text{g}/\text{cm}^2$ Au layer acts as a binder between the Gd and the C. The C was evaporated with an arc, and finally the Au layer was evaporated.

III. The Al_2O_3 hybrid circuit boards consist of

Al_2O_3 of 1 to 2 mm
NiCr of a few $\mu\text{g}/\text{cm}^2$
Au of 5 to 10 μ

In this case the NiCr acts as a binder between the Al_2O_3 and the Au. The NiCr was evaporated from a tungsten spiral and covered with a thin layer of Au in the same vacuum to prevent its oxidation which would compromise the adherence. The Au layer was then brought to 5 or 10 μ by a triode sputtering system. Although similar circuit boards are commercially

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The method for non-contact temperature measurement by the interference of laser beams (NIM 167, 139, 1979) has been improved so that the surface temperature of a substrate during vacuum evaporation can be monitored. Experimental results show that if the average bulk temperature of the substrate increases slowly (about $1^{\circ}\text{C}/\text{min}$), the surface temperature will be about the same. But if the bulk temperature increases rather fast (about $10^{\circ}\text{C}/\text{min}$), the surface temperature will be considerably higher. The difference could be in the order of ten degrees.

The efficiency and uniformity of ion bombardment as a pre-treatment of the substrate surface are investigated by measuring the temperature increment of the substrate. Experimental results show that the conventional design of the bombarding electrodes used in many ordinary vacuum coating plants are not satisfactory enough. A new device including a pair of planar electrodes or a half-shielded cylindrical rod is used, by which the efficiency is raised about 4 times and the temperature difference on the substrate surface is significantly reduced. Furthermore, the glow discharge during bombardment is limited in the space above the electrodes and thus the dust particles, if there is any, from the baseplate of the vacuum chamber can be avoided.

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Measurement of self-supporting films

In many applications of thin foils (e.g. supports for thin layers used in nuclear measurements, windows, stripper foils, energy filters) it is important to know the areal density of the foils and their lateral uniformity with high accuracy. A method installed and improved at CBNM has been presented at the 8th International Vacuum Congress at Cannes, September 1980 (1). The abstract of the paper reads as follows :

"An improved method to determine the thickness of thin foils, in the region of several $\mu\text{g cm}^2$ to several mg cm^{-2} by measuring the energy loss of alpha-particles traversing these foils is described. The method is particularly sensitive for mono-energetic alpha-particles of low energy. Using a simple experimental arrangement and applying a modified slightly asymmetrical Gaussian fit to the measured peaks, sensitivities in the determination of areal densities of a few tenths of a $\mu\text{g cm}^{-2}$ can be obtained".

The peak fitting method used in the evaluation of the absorption measurements is described in an internal report (2).

- (1) H.L. ESCHBACH, R. WERZ, I.V. MITCHELL, P. RIETVELD
Highly accurate thickness determination of thin self-supporting foils by the alpha-absorption method.
Proceedings 8th International Vacuum Congress, Vol. 1, 267 (1980)
- (2) R. WERZ, I.V. MITCHELL
Least squares fitting and deconvolution of alpha peak from surface barrier detectors.
CBNM/MS/1/80

J. VAN AUDENHOVE - J. PAUWELS

Central Bureau for Nuclear Measurements

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TARGET LABORATORY ACTIVITIES 2nd SEMESTER 1980

During this reporting period 280 samples were delivered covering 21 different applications. Details are given in Table 1.

Table 1.

Samples delivered second semester 1980

Materials	Applicants (See list (a))	Number of samples	Definition Method (See list (b))	Preparation Method (See list (c))
²³⁵ U	(1)(2)	6	α-count. - IDMS	ES
²⁴¹ Pu	(1)	4	α-count. - IDMS	ES
²⁴¹ Pu	(3)	1	α-count. - IA	Solution
²⁴¹ Pu/ ²⁴² Pu	(1)	1	α-count. - IA	ES
²⁴² Pu	(1)	1	α-count. - IA	ES
Al-U alloys	(1)	7	QA	LM
Al-B	(4)	22	QA	LM
Al-Au	(5)	9	QA	LM
-In				
-Mn				
-Zn				
-W				
-Co				
-Cu				
-La				
Zr-Au				
V-Ga	(6)	1	QA	LM
Nb-B	(7)		QA	LM
nat.Li	(8)	2	DC	M-Pr-Mach.-Canning-VD
⁶ LiF	(9)	4	IA - MD	VD
⁵⁰ Cr	(1)(9)	1	DC - MD	Pr - C
⁵² Cr	(1)(9)	1	DC - MD	Pr - C
⁵¹ Cr	(1)	20	-	ES
C	(1)	200	-	Pol

(a) List of applicants

- | | |
|----------------------------|-------|
| (1) C.B.N.M., Geel | (EUR) |
| (2) C.E.A., Saclay | (F) |
| (3) K.f., Karlsruhe | (FRG) |
| (4) R.University Ghent | (B) |
| (5) A.T.E.C., Turnhout | (B) |
| (6) U.I.A., Antwerpen | (B) |
| (7) Rockwell International | (US) |
| (8) J.R.C., Ispra | (I) |
| (9) S.C.K., Mol | (B) |

(b) List of Definition Methods

- | | | |
|----------|---|------------------------------------|
| MD | : | Mass Definition |
| α-count. | : | Counting of α-particles |
| IDMS | : | Isotope Dilution Mass Spectrometry |
| DC | : | Dimensional Control |
| IA | : | Isotope Analyses |
| QA | : | Quantitative Alloying |

(c) List of Preparation Methods

- | | | |
|-----|---|--------------------|
| ES | : | Electrospraying |
| VD | : | Vacuum Deposition |
| LM | : | Levitation Melting |
| Pr. | : | Pressing |
| C | : | Canning |
| M | : | Melting |
| Pol | : | Polishing |

Samples in the form of thin films or foils were prepared by electro spraying, including suspension spraying, spraypainting, vacuum deposition, cathodic sputtering or rolling.

Alloys with certified composition or bulk samples were produced by melting, including high frequency levitation melting, rolling, powder metallurgy and conventional machining techniques.

The degree and quality of the characterization of the samples and targets depended on the application. It varied from a crude film thickness measurement by an oscillating quartz device to the extremely accurate mass assay by alpha-counting and isotope dilution mass spectrometry.

An important effort has been made for setting up and testing of canning, pressing, weighing, welding and dimensional control facilities needed for the fabrication of U_3O_8 reference materials for non-destructive analytical purposes.

The fabrication of a first set (0,3 % ^{235}U) of 140 pieces is in progress.

The preparation of a certified V- ^{238}U alloy for dosimetry

High-purity fissionable dosimeters of ^{235}U , ^{238}U , ^{239}Pu , ^{240}Pu , ^{237}Np etc. are essential for the monitoring of fuels and materials irradiations in Light Water Reactors, Fast Breeder Reactors and Controlled Thermonuclear Fusion Reactors.

At several occasions the ASTM-Euratom dosimetry working group recommended the intensification of interlaboratory efforts on fissile dosimeter fabrication, quality assurance and assay.

These dosimeters must be in form of needles with diameters between 0.5 and 0.7 mm and with lengths of about 10 mm. They have to be encapsulated in high purity materials and the overall diameter and length may not be more than 1.3 and 12 mm respectively. They must resist to temperatures up to 800° C. In some applications the fissionable materials have to be diluted (0.1 to 10 wt %) in a suitable matrix in order to avoid :

1. Excessive activity (difficult to handle and to measure),
2. Neutron self-shielding perturbations which may be possible in Light Water Reactors.

The mass of fissionable material in each dosimeter (total mass about 10 mg) must be known at ± 1 % or better. Uniformity in composition from dosimeter to dosimeter must be at least ± 1 %.

A considerable amount of development work leading to the preparation of high quality dosimeters in form of ceramic MgO wires containing 0.1 wt % ^{235}U , ^{238}U , ^{237}Np and ^{239}Pu (as oxide) has been performed in ORNL since 1971 (1) (2).

The European users of dosimeters consider it as most important to encourage the development at CBNM of an easily accessible stock of accurately defined fissionable dosimeters.

In view of our experience in quantitative alloying, CBNM preferred to make vanadium base alloys. The US-Department of Energy and ORNL delivered pure vanadium (low in Ta) and highly enriched fissionable isotopes in metallic form for the preparation of vanadium dosimeter alloys containing ^{235}U , ^{238}U , ^{239}Pu and ^{237}Np .

A first V-alloy containing 2 % ^{238}U has been prepared by quantitative alloying using induction levitation melting. Under the assumption that the loss during this operation is only due to uranium the composition can be calculated as follows :

$$\text{V} + (1,99 \begin{matrix} + 0,00 \\ - 0,02 \end{matrix}) \text{ wt \% U}$$

After thermal treatment at 950° C during 200 hrs this alloy has been rolled and swaged into wire of 0,5 mm diameter. Needles of about 12 mg, randomly taken from this wire, have been used for :

1. Determination of U contents by isotope dilution mass spectrometry (at CBNM-MS),

The mean U-content (n = 6) ; 1,977 % \pm 0,009 %

^{238}U content in uranium : 99,9977 wt %

2. Control of uniformity in composition by activation analyses (at SCK, Reactorphysics).

For minimum amounts of 12 mg the uniformity is better than 0,25 % (1s),

(1) Nuclear Technology Vol. 25, p 224-236, Febr. 1975

(2) H.L. Adair, E.H. Kobisk, J.A. Setaro, T.C. Quinby and J.M. Dalley
NUREG/CP-0004, p. 987 (1977)

Fellowship at the Central Bureau for Nuclear Measurements
(Joint Research Centre of the European Commission) b - 2440 Geel, Belgium

The European Commission runs a scheme of further training for scientists and technologists by awarding grants to suitable applicants to carry out research programmes in the establishments of the Joint Research Centre (JRC).

Applications are invited for fellowships to participate in the work of the Nuclear Target Preparation Group at the Central Bureau for Nuclear Measurements - JRC Establishment Geel.

The following subjects are of particular interest :

- The development of techniques for the preparation of thin actinide deposits by electrolyses.
- The preparation of pure Vanadium and Niobium with low Ta content.

A grant can be awarded at various levels of training, post graduate dissertations, PhD thesis, ...

Applicants should be nationals of one of the member states of the Community.

In the area of training up to PhD level, it would generally be essential for the applicant to have the backing of a higher educational establishment.

Send applications to : Mr. J. LINSEN
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B - 2440 GEEL
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