

**INTDS
NEWSLETTER**

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Cover picture: Chris Ingelbrecht loading an electrodeposition cell for 'molecular plating' of stable isotopes for the accerator targets.

Editor's note

Dear Colleagues,

This is the last issue of the INTDS Newsletter edited at the JRC IRMM. Further editorial work is returning to the newsletter's birthplace Argonne National Laboratory, USA where George E. Thomas prepared the first edition in 1974.

The change is due to Chris Ingelbrecht's, long-standing editor of INTDS Newsletter, leaving the IRMM (and the target preparation field) to take up another post at the European Commission. Just for this issue, while I am for a year-long Visiting Scientist assignment, I have tried to take over his editorial duties.

I would like, on behalf of all Chris's friends to wish him a lot of successes in his new job. A lot of successes and a lot of luck.

I would also like to wish all of you a happy, prosperous 2003.

Anna Stolarz

The 21st World INTDS Conference

Argonne National Laboratory,
Argonne, USA, 4 – 8 November 2002

The conference was attended by over 60 participants from 14 countries. Unfortunately some registered attendees were unable to show up due to visa problems. Thirty-three (out of 38 submitted) contributions were presented in 8 sessions covering wide variety of subjects. The sessions were preceded by plenary talks given by speakers invited from ANL Argonne and NIST Gaithersburg, USA and GSI Darmstadt, Germany. Those speakers presented a general overview of projects, problems or experimental aspects related to the session subjects. These talks showed that demand for high power density strippers and for radioactive isotope targets would grow with development of RIB facilities.

Apart from the daytime talks, John arranged as well the 'evening sessions': on *Nuclei at the Limits of Stability* during the Conference Banquet and on *Weird Science* during the 'pizza party', one of the 'get together' events.

During the Conference Banquet the INTDS awards were presented to Pete Gobby, Hans Maier and Joe Tracy for their contributions to the Society itself and to the development of the target preparation techniques.

Thanks to the hard work by John Greene, Margo Smith, Janelle Neubauer and Joan Brunsvold conference passed in a very nice and friendly atmosphere.

Anna Stolarz

Editor

Award presentation at the 21st INTDS conference in Argonne, Nov. 6, 2002

It is quite unusual that the INTDS honors three members at the same time. The reason for this is not the fact that they have retired or will soon retire, but it might be the last chance to pay tribute to them during one of our conferences.

All three of them proved high responsibility for the representation of the INTDS and their engagement formed the INTDS remarkably as it was outlined in the speeches at the banquet. They still will be active in our society with their expert advice and as reviewer for our proceedings.

I hope all of you will forgive me that I had included also my personal view and some caricature descriptions, which I had experienced when collaborating with the awarded colleagues.

Peter Maier-Komor
INTDS president (1998 – 2003)

Joe Tracy spent his entire career of over 40 years working at the ORNL calutrons, retiring in December 1999 as the Manager of the ORNL Isotope Enrichment Program. During that period, he became an internationally recognized expert in the electromagnetic enrichment of isotopes. The contributions that enriched calutron products (both stable and actinide isotopes) have made in the research, medical, and industrial fields are too numerous to list and Joe has had a hand in almost all of them. Even in retirement, Joe continues to make important contributions to the ORNL Isotope Program as a consultant.

He has been a dedicated member of the INTDS since 1975 and has provided valuable assistance to members and to the rest of the world with their enriched isotope needs. In recognition of his important role in activities of importance to the Society, the INTDS presents this plaque to Joe, a valued friend.

Pete Gobby had his first contact with the INTDS in Darmstadt at the 14th World Conference in 1988. There he presented a paper authored by two of his colleagues at the Los Alamos National Lab. Pete reported a novel technique to measure the divergence and density of a neutral particle beam. More remarkably, before attending, he had agreed to shoulder the 15th World Conference. How this came to be Pete's responsibility could be traced to a tour through the LANL Target Fabrication Lab presented to Jan van Audehove, and to Jan's well-documented charm. In any case, target maker's luck had landed a heavy lifter for the INTDS.

Pete's BSc in physics was from California State University at Fresno. In 1977, he achieved MSc and PhD degrees in physics at Montana State University in Bozeman. There and at the Physical Sciences Lab of the University of Wisconsin in Stoughton, where an electron storage ring was used only as an ultra-violet or soft x-ray source, his main field of interest was the surface physics of solids. His dissertation was titled "Ultra-Violet Photo Emission Spectroscopy of Single Crystal Tin Oxide

Utilizing Synchrotron Radiation." After graduation, he worked and taught as a post-doc for two years in Bozeman. Prior to the LANL's Target Fabrication Lab, Pete worked 1½ years for a company in Los Alamos that developed streak cameras. These cameras use pico-second pulses from fluorescent sources excited by a laser.

Regarding his 21 years at LANL's Target Fabrication Lab, he mused recently that his group of 60-80 people had changed its name about seven times. Pete served in this group as a team supervisor of 5-9 people for 10-12 years. Pete's group made small parts of atypical targets for ion-beam and laser weapon physicists, as well as for research in Inertial Confinement Fusion (ICF). ICF was declassified after a few years of activity. And this presented an opportunity that Pete seized to present powerful techniques of fabrication unknown to most of us. For example, details were reported for making thin films of tungsten in fluidized beds by use of chemical vapor deposition with dissolvable mandrels: amazing stuff!

Pete was the single author of 15-20 papers and was listed as one of the authors of 40-50 more. Several of Pete's papers are in the Journal of Vacuum Science, which sometimes published the proceedings of the yearly meetings of the national target fabrication labs.

Pete, as host for the 15th World Conference, graciously interpreted and presented the papers of two people who were unable to attend. He was elected to the INTDS Board that year, 1990.

He became an excellent reviewer of the INTDS proceedings. In one case I had to apologize and he had won my deep respect. He had reviewed a carbon paper of Günther Dollinger in which a very long equation was presented. This equation was derived by Günther for his dissertation and was checked not only by myself but also by three professors of the examination committee for his dissertation. Pete, however, trusted no one. I became angry with him, but he explained me with his calm nature that he had investigated relevant literature in the LANL library and thus could control the questionable derivation and told me exactly where the error was. I became deeply impressed. If there would be more reviewers of his knowledge no errors would be printed in the journals.

When I became vice president of the INTDS in 1994, I immediately offered Pete to be nominated as the next vice president. In those days he told me he would consider it, but in 1998 he informed me that he could not take this task, because he wanted to go on an early retirement. Otherwise he would have been the next president of the INTDS.

Pete resigned from the INTDS board in 2001, when he retired from LANL, his good-natured wit and levelheaded advices were always much appreciated. Currently, living in California, he has been drawn back to teaching physics, he is finding a little time for golf and, predictably, is commuting a week at a time with consulting work at LANL.

In addition he remains active as INTDS member and still will review papers for our proceedings as he did in the past and we wish that he can do it for many future INTDS proceedings to be published in Nuclear Instruments and Methods in Physics Research.

With gratitude, we offer this heavy lifter an INTDS Award of Achievement.

Hans J. Maier: It is my pleasure to present this (the 3rd) INTDS award to my colleague from Munich - Hans Maier. Before I give this plaque to Hans let me explain my motivation to suggest him for an award.

Hans received his Physics Diploma in 1966 and his PhD in 1968 from the University of Freiburg, Germany, where he worked at the Van-de-Graaff Accelerator Laboratory in the γ -ray spectroscopy groups of H.J. Rose und J.G. Pronko. His main interest was with light nuclei. In particular he contributed to the investigation of the level schemes of ^{14}N and ^{23}Na . After graduation, he worked for three years for the "Röhm und Haas" Company in Darmstadt. As head of the Isotopes Laboratory, he

was responsible for the development and characterization of plastic scintillators as well as for analytical services based on radioactive isotopes.

In 1971, Hans started his career as a target maker in Munich. He became a specialist in metallurgical procedures related to target technology, ion beam sputtering, and radioactive target preparation. Outstanding examples of his work are vacuum condensed ^{10}Be , ^{210}Pb , ^{226}Ra , ^{244}Pu , and ^{248}Cm targets.

You may wonder why we have two independent target labs in Munich at the same tandem accelerator (now Maier-Leibnitz Laboratory). This is easily explained. There are two universities in Munich which sometimes like to fight against each other: One is the LMU (lower Munich university) to which Hans belongs and the other one is my home university the TUM (top university of Munich).

I had met Hans for first time in a budget discussion in 1972. He was incited by his boss to defeat the enemy which meant to search for reasons why my budget should be cut as much as possible. This blocked up further communications between us for a while.

The first chance to make peace would have been the Chalk River conference in 1974, but unfortunately even myself was informed too late and thus there was no chance to explain Hans the importance of the INTDS. Therefore only I attended. The next chance was the 4th INTDS conference in Argonne in 1975 of which I had informed him and we traveled seat by seat on the same plane.

On this flight we both decided to bury the hatchet and to cooperate as much as possible, which meant, with the exception of equipment for routine procedures, specialized devices should not be installed in both target labs in order to save money and training time for qualification of manpower.

From now on Hans attended all INTDS conferences and always contributed with one talk in the minimum.

We co-hosted the INTDS conference in Munich in 1978, which, after the symposium in Oak Ridge in 1971, was the second one with its proceedings published in NIM. After this the INTDS decided that this journal should publish all our proceedings.

Hans worked as co-editor for three NIM issues of our INTDS conferences.

Hans was a very active and successful president of the INTDS from the years 1990 until 1994. From 1990 until 2002, Hans organized and presided the Targetry Session at the biennial Accelerator Conference in Denton.

Next year he must go on retirement even if he feels too young to do this step. Fortunately there is a chance to work as a consultant for his target laboratory after this date.

I am sure the INTDS will have him for many more years still contributing to this field.

HANS: In recognition of your work as a famous target maker and as an excellent promoter of the INTDS you get this plaque.

I.N.T.D.S. INTDS Electronic Mailing List

Pawell Barber

Florida State University, Tallahassee, USA

Introduction

An electronic mailing list has been established for use by all members of the INTDS. The list allows any member to contact all subscribers using a single e-mail address - ***intds@lists.fsu.edu*** - facilitating discussion among members. Subscription is limited to INTDS members and select others with board approval. The list is served by Florida State University Academic Computing and Network Services and administered by Powell Barber.

Privacy Issues

Subscription to the list requires administrator approval. All INTDS members listed in the 2002 conference materials will be automatically approved upon receipt of a subscription request. Subscription requests from those unknown to the administrator will be submitted to the board for approval. Only subscribers may post to the list. Messages of the list are archived and available for viewing by any html client software. The archives are not restricted to INTDS members and may be viewed by anyone. The mailing list software strips e-mail addresses from header information prior to posting to the archives. However, e-mail addresses imbedded in the text are not stripped. Those concerned about this should avoid using signature files or including e-mail address information in the body of the message.

How to Subscribe

Subscription and account management may be accomplished through either web or e-mail interfaces, or by contacting the administrator directly. For the web interface, simply access ***http://lists.fsu.edu/mailman/listinfo/intds*** with any forms capable web browser. A link from the INTDS home page, ***http://www.intds.org*** is available. Simple instructions are given that allow one to access the archives, subscribe, unsubscribe, and edit account options.

Alternatively, one may request information on the e-mail interface by sending e-mail to ***intds-request@lists.fsu.edu*** and including the word ***help*** in the subject line. This may obviously be done prior to subscription.

While the web interface is certainly the easiest way to subscribe and manage your account, any request may also be processed through the administrator by sending e-mail to ***barber@nucmar.physics.fsu.edu***.

Technical Details

The mailing list server is maintained by Florida State University's Academic Computing and Network Services, which are located in Innovation Park, Tallahassee, FL, USA. The server software is Mailman, the GNU Mailing List Manager. Additional information on this software is available from ***http://www.list.org/***.

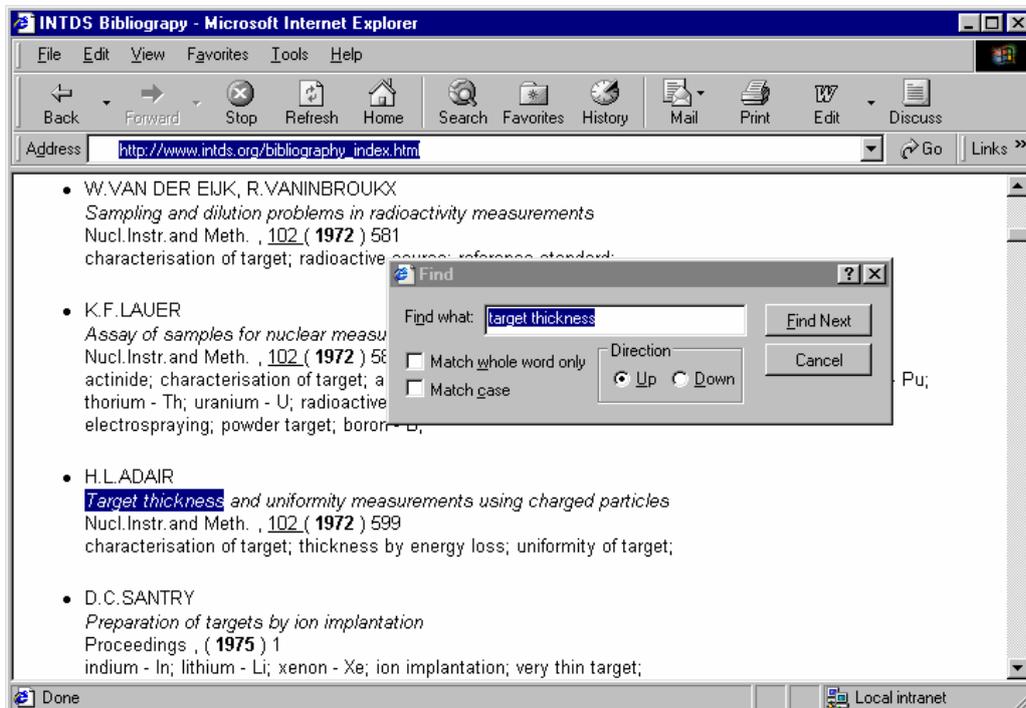
INTDS bibliography index

Piotr Robouch, Anna Stolarz*

IRMM, Geel, Belgium

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The INTDS bibliography index, originally created by Edith Gursky, was later converted into an electronic version by Piotr Robouch and was available as MS Word or Excel or LOTUS files. Now it is available as a link from the Society's web page <http://www.intds.org>. The search for the relevant articles can be performed directly from the website and the file does not need to be downloaded.



Those INTDS members who are used to work with Word and/or Excel can download INTDS.doc and/or .xls files.

* Temporary at IRMM, Geel as a Visiting Scientist till middle of October 2003

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Definitions established for the utilization in INTDS publications

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Chuck Gibson had presented a talk about polyimide foils at our conference in Argonne. There for my opinion he did not define the difference between film and foil.

Historically our society (INTDS) was founded for the development of targets utilized for the interaction with a high-energy ion beam produced by an accelerator. Since for most nuclear physics experiments the target must be thin enough to keep the not avoidable energy loss and straggling small in order to identify the interaction of one swift ion with one target atom. Therefore a thin target layer on a relatively thick substrate cannot be utilized. Thin foils are required and often the adjective “self-supporting” is enclosed to make absolutely sure that the target material is not supported by another thin foil (e.g. carbon or plastic foil) or by a mesh.

In contrary a thin film is always deposited on a thick substrate and thin film technology is a widely used industrial discipline (e.g. for optical coatings or integrated electronic circuits) with mostly complete different demands and relevant parameters which even is reflected in different definitions e.g. for thickness as is shown later in this article.

Since we are involved in a very special discipline we need to define very carefully our professional wording and units in a way that they show physical evidence and that not only insiders can understand them or can derive them from fundamental units.

The definition for “film” and “foil” can be found in dictionaries. I used as reference: OXFORD ADVANCED LEARNER’S DICTIONARY, Oxford University Press, Walton Street, Oxford OX2 6DP, 5th Impression 1991:

film (of something): thin coating or covering on or over something

foil: metal rolled or hammered (or otherwise processed) into a very thin flexible sheet. e.g. aluminum foil such as wrapped round bars of chocolate.

Private comment: Of course this definition does not exclude organic materials e.g. plastic foils.

Definition of thickness units: The relevant unit for a target for nuclear physics application is the amount of nuclei or atoms per unit area, only with this unit cross sections can be calculated accurately. The target thickness which is presented to the experimenters is normally given in mass per unit area (e.g. $\mu\text{g}/\text{cm}^2$). Using fundamental constants they easily can deduce the amount of nuclei per unit area. Questionable seems to be only: is it allowed to name such a unit as “thickness” or do we need a different nomenclature?

The criterion is again that the unit could be converted into a height measured by the S.I. unit meter [m]. This conversion is easily be done when knowing the density ρ (in kg/m^3 or as sub unit g/cm^3) of the material. There is exactly our problem we normally do not know the exact density, because thin films normally have a reduced density in comparison to the bulk material. So even if we would measure the exact height of the target this could not be converted correctly to amount of atoms per unit area.

Knowing these problems e.g. John Stoner prefers to use “areal density”, but I doubt that this nomination can solve the problem. We insiders know what he means, but how to react if someone does not know? The normal procedure would be to derive S.I. unit of it. There are two possibilities and both lead to a wrong result: the unit for area is $[\text{m}^2]$ and the unit for density is $[\text{kg}/\text{m}^3]$. The division of both units results in $[\text{kg}/\text{m}^5]$ and the multiplication of both

leads to [kg/m], whereas our standard thickness unit t [g/cm^2] can easily be reduced into a height value d [m] when introducing the density ρ of the target material by dividing our thickness unit by the density:

$$\rho \cdot d = t.$$

Most target thickness measurements we do by applying a micro balance for weighing and determining the area of the foil or we use a quartz crystal thickness monitor which is directly calibrated by fundamental constants into our desired units of [g/cm^2].

Most quartz crystal thickness monitors are made for industrial purposes. Their users want to have the height of the deposited layer to compare their strap height with the distance between the straps or to calculate the electric resistance of the length of one strap. Therefore they accept the difference of the programmed bulk density to the actual density of their thin film. Many of these users do not even know the Sauerbrey equation [1] which clearly explains that a quartz crystal can only measure the thickness in units of [g/cm^2]. Since this equation is only a very simple approximation more detailed calculations were performed [2 and ref. therein]. For those users who can only measure the resonance frequency of the quartz before and after deposition I would recommend [3].

Conclusion: “thickness” is the most simple and correct notation for the unit [g/cm^2], if you do not like it, you could use “mass per area”, may be even “areal mass” or “mass coverage”.

[1] G. Sauerbrey, Z. Physik 155 (1959) 206.

[2] P. Maier-Komor, Nucl. Instr. and Meth. A 236 (1985) 641.

[3] P. Maier-Komor, Nucl. Instr. and Meth. A 362 (1995) 139.

P.S. Manual for commercial Quartz Crystal Thickness Monitors for correct unit setting:

In case you want to read your thickness in units of [$\mu\text{g}/\text{cm}^2$] and the deposition rate in [$\text{ng cm}^{-2} \text{s}^{-1}$] you must enter the following parameters:

First, enter the acoustic impedance for quartz crystal material. Depending on the manufacturer of the thickness monitor you must install either “1” for standard or the value 8.834.

If your monitor reads the thickness in [$\text{k}\text{\AA}$] and the rate in [$\text{\AA}/\text{s}$] you should install a density of $0.1 \text{ g}/\text{cm}^3$ and a tooling factor of 100%.

In case you cannot enter such a low density, then you should enter the density of $1 \text{ g}/\text{cm}^3$ in combination with a tooling factor of 1000% or if this is not possible a tooling factor of 999.9% has sufficient accuracy.

If, however, your monitor reads the thickness in [nm] and the rate in [nm/s] you should install a density of $10.0 \text{ g}/\text{cm}^3$ and a tooling factor of 100%. Then these units read the thickness in [$\mu\text{g}/\text{cm}^2$] or in [mg/cm^2] for the case that [μm] is indicated but always the rate is shown in [$\text{ng cm}^{-2} \text{s}^{-1}$].

The thickness and rate reading are, of course, only valid for the layer deposited on the quartz. The calibration of the thickness on the substrate relative to the one on the quartz cannot be taken in account by changing the tooling factor. On the other hand you know directly the deposited water thickness on the quartz after venting. Unfortunately on both sides of the quartz water is deposited, this means if you read e.g. $0.8 \mu\text{g}/\text{cm}^2$ the water layer thickness is only half of this value which means $0.4 \mu\text{g}/\text{cm}^2$. This half value is only an estimation, because the adsorption of water might be different for the electrode material on the back side of the quartz and the deposited target material.

Improved procedures for making ^{13}C foils

John O. Stoner, Jr

ACF-Metals

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We have improved procedures that were used earlier [1] for the production of isotopic carbon ^{13}C foils.

These foils are made by electron-beam evaporation of powdered amorphous ^{13}C [2]. The powder is ground in a mortar with a little xylene, and packed into a tungsten dimple boat with the ends cut off (Mathis S8D-.010W). The ^{13}C charge is outgassed slowly with **very low** emission current at first. Even with dither to spread the electron beam over a 20-mm distance, there are some spits; total net emission current is kept below about 12 mA to minimize these. With emission currents at this level, there is little probability of damaging the boat. Maximum evaporation rates are typically 0.05-0.1 nm/s at the substrates located 20 cm from the source. The electron beam cuts a slot in the evaporant charge. It is necessary then to open the evaporator and reorient the charge, sometimes adding some ^{13}C powder. Outgasing is not necessary if the charge is only reoriented. Five or more pumpdown cycles are needed to make foils 0.5 μm thick (areal density 100 $\mu\text{g}/\text{cm}^2$). Venting is done with nitrogen. Evaporation is continued until the total thickness indicated by the quartz-crystal-monitor QCM head is about 600 nm, corresponding to about 100 $\mu\text{g}/\text{cm}^2$ at the substrates.

Freshly cleaved mica pieces, 25 mm \times 75 mm, about 0.05 mm thick, can serve as substrates. With these, the risk of contamination from a parting agent is avoided, and floating is usually reliable but sometimes slow. Foils at 100 $\mu\text{g}/\text{cm}^2$ are baked at atmospheric pressure in a nitrogen-flushed oven before floatoff. They typically separate slightly from their substrates if baked for an hour at 488 K. Subsequent floatoff is relatively easy. However, only small pieces of foil, typically 1-2 cm on a side, can be obtained without cracks. We suspect that even slight flexing of the mica may delaminate it, and crack the foil as a result. There is also an unfounded suspicion (from rumors from electron microscopists) that contamination may occur as tiny flakes of mica in such foils.

Parting agents that have been used by other experimenter and ourselves include adenine, betaine-sucrose, and detergent. We have found that none these is satisfactory for electron-beam evaporated ^{13}C . None can be used at temperatures much above room temperature. Removal of the evaporated layers by floating is always uncertain. When adenine is used, hot water (typically at 348 K) must be used for floating. Foils often curl and sink if they do float off, and do not reliably float off after several months' storage. There may be a nitrogen contamination due to the adenine, or a ^{12}C contamination from any of these parting agents. Baking foils in dry nitrogen at 473-573 K sometimes makes them release better, but sometimes they then don't float off at all.

The best results so far are obtained starting with glass microscope slides, 25 mm \times 75 mm, as substrates. Slides are first washed with Palmolive detergent (or other dish detergent) and warm water, rinsed and dried with paper towels. They are mounted as the lower surface of a flat tantalum box containing an array of alumina-insulated tantalum heater wires. Other investigators [3] have used substrate temperature of 160-200 degrees Celsius, so we use this range initially. The QCM is mounted near the heater box, at approximately the same height as the substrates.

Barium chloride is used as the parting agent, evaporated from Mathis S17B-.005Ta boat to a thickness of about 150 nm.

However, such foils are not yet satisfactory; thick foils break up, curl and sink upon floating. A further heat treatment is needed to remove the stresses in the foils. Two methods have been used successfully:

1) Foils are laid face down on clean glass slides and baked at 670 K in dry nitrogen for about 1 hour.

2) Foils are baked in vacuum at 670 K for about an hour.

In either case, foils are then almost completely released, and are crinkly and shiny. They float easily, and float best the slide is held nearly parallel to the water surface.

Foils at $100 \mu\text{g}/\text{cm}^2$ made in both ways were successfully cut into about 25-mm squares with scissors, while the foils were on the water surface. These could be picked up over an aperture having diameter 16 mm easily, with the frame held vertically.

An $85 \mu\text{g}/\text{cm}^2$ foil made on a plain glass slide also released when baked in vacuum (method 2 above) so maybe a parting agent **is not necessary**.

The maximum ^{13}C areal density that can be reliably produced is $100 \mu\text{g}/\text{cm}^2$, though occasionally thicker foils can be made.

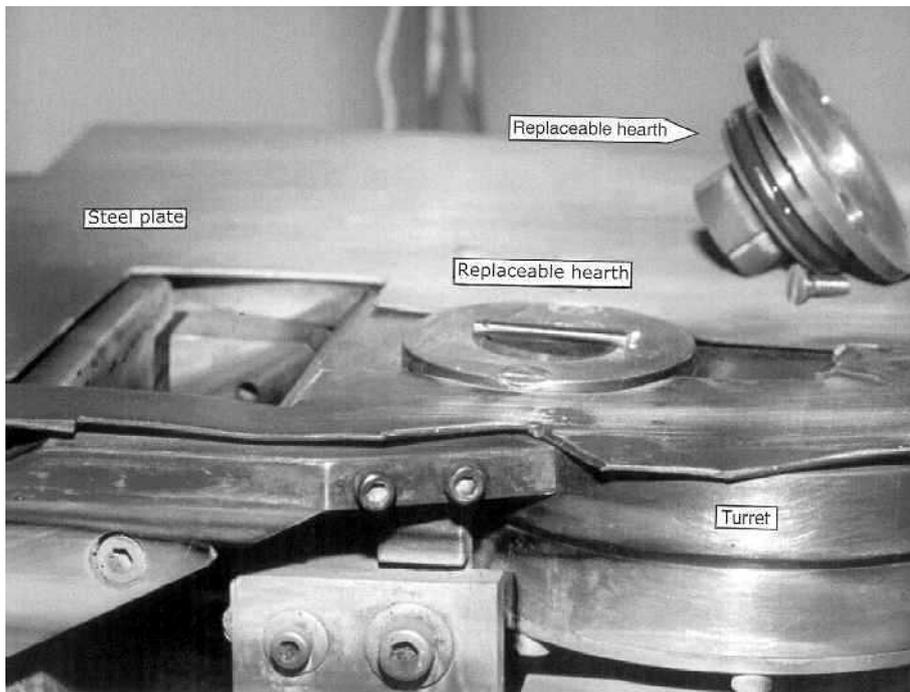
References:

- [1] J.P. Greene, G.E. Thomas, A. Garcia, A. Komives and J.O. Stoner, Jr., Nucl. Instr. and Meth. A438 (1999) 52-57
- [2] Obtained from Isotec, Inc., 3858 Benner Rd., Miamisburg, OH 45342, USA
- [3] M.B. Chatterjee, C.Pruneau, C.Rangacharyulu and C.St.-Pierre, Nucl. Instr. and Meth., 227 (1984) 15-18

Replaceable copper hearth configured for use on Temescal-type electron gun.

John O. Stoner, Jr
ACF-Metals
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The original rotatable turret had four depressions serving as movable hearths machined in it. These were difficult to clean. The gear assembly used to turn the turret had become sufficiently worn that it was only possible to use one hearth during a single pumpdown cycle, in any case.



The fins separating the four hearths were machined off, and then one hearth was bored out, leaving a cylindrical hole having diameter about 30 mm and depth 10 mm to accept a replaceable hearth, which is held in place with two machine screws.

On the photograph you can see a 3.2-mm diameter tungsten rod about 2 cm in length lying in the hearth, ready for evaporation. A steel plate covers the unused parts of the turret. For the purposes of this photograph, a spare replaceable hearth lies on top of that plate, showing the O-ring seal that contacts the wall of the cylindrical hole.

With this arrangement a freshly cleaned hearth can be readily used for each new evaporation, without the need to do the cleaning *in situ* in the evaporator. However, the removal of the fins that originally separated the hearths has reduced the quality of the focus of the electron beam. A stainless steel shield (not shown) now must be used to intercept the parts of the electron beam that miss the turret and its steel plate. Without that shield, damage occurs to the bell jar by the electron beam.

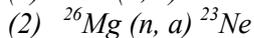
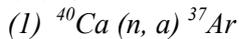
This is a perfect example of Eric Sevareid's Law; "The chief cause of problems is solutions."

Gaseous Radiochemical Method for Neutron Monitoring

D.N.Abdurashitov, E.A.Koptelov, S.G.Lebedev, and V.E.Yants

Institute for Nuclear Research RAS, 60th October Anniversary Prospect, 7a, Moscow, 117312, Russia

Development of new methods for measurement of fast neutron fluxes remains an actual problem. Measurements of neutron flux in conditions of high temperatures and in intensive fields of gamma-quantum are especially inconvenient. Such conditions of measurements are usual in reactors on fast neutrons, at realization of thermonuclear researches and in experiments with accelerators. Frequently access to a point of measurement is complicated (for example, in reactors on fast neutrons). This gives rise to limitation of usual activation methods. Especially, when long measurements in a on-line mode (monitoring) will be carried out. We offer to use for monitoring of fast neutron fluxes the reaction:



Feature of these reactions is that nucleus - products are inert radioactive gases ${}^{37}\text{Ar}$ and ${}^{23}\text{Ne}$. It was earlier shown, that ${}^{37}\text{Ar}$ with zero activation energy leaves the intercrystalline space (a gas phase) of crystal lattice of a dehydrated powder of oleate calcium - CaC_2O_4 . This unique property of the given compound of calcium allows realizing the following circuit of continuous measurement (monitoring) of fast neutron flux. The ampoule with granulated powder CaC_2O_4 is located in area of measurement and through an ampoule on thin tubes blows transport gas (helium). The helium flow carries away ${}^{37}\text{Ar}$ formed in reaction (1) and transfers it in flowing ionization detector of decays where measurement of ${}^{37}\text{Ar}$ decay speed is made. This quantity is unequivocally connected to the fast neutron flux density in the location of an ampoule. Such method of registration of neutrons has a number of advantages:

- a) Tolerance to gamma-quantums (detectors of decays of ${}^{37}\text{Ar}$ and ${}^{23}\text{Ne}$ can be removed far enough and shielded);
- b) Small time of the response for change neutron flux (it is defined by the speed of gas exchange in an ampoule and the counter, and can be adjusted up to shares of second);
- c) High-temperature properties (some decomposition of CaC_2O_4 was observed at $t > 350\text{C}$; working temperature of an ampoule with CaC_2O_4 is $t \ll 300\text{C}$);
- d) There are no moving parts and, as a consequence, simplicity and reliability in operation;
- e) ${}^{37}\text{Ar}$ is small-dangerous radioactive gas (pure e-capture), ${}^{23}\text{Ne}$ – short-living isotope ($T^*_{1/2} = 37 \text{ sec}$);
- f) Contrary to any other circulating schemes in which activate substance goes through a contour (and, accordingly, full activity is integral on a contour), speed of ${}^{37}\text{Ar}$ (${}^{23}\text{Ne}$) formation is defined by the neutron flux density only in the location point of an ampoule with CaC_2O_4 (MgC_2O_4);
- g) Due to solid state of target substance and a small vapor pressure of CaC_2O_4 (MgC_2O_4) any carry of substance of a target by transport gas is absent;
- h) Absence of a liquid phase automatically solves a problem of low speed of gas exchange at babbling between transport gas and substance of a target;
- i) The method is of interest for the metrological purposes since it is absolute (at a known spectrum of neutrons), in an accounting mode speed of count of ${}^{37}\text{Ar}$ (${}^{23}\text{Ne}$) decays in the flowing detector is unequivocally defined by known parameters: nuclear constants, the weight of Ca in a target, the working volume of the detector, the rate of transport gas flow and – a density of neutron flux;

Proposed radiochemical detectors has been successfully tested on the deuterium and tritium targets and 600 MeV linear proton accelerator-driven neutron target of RADEX facility of INR RAS Moscow Meson Factory.

30th anniversary of publication about Betaine parting agent

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At the INTDS conference in Oak Ridge in 1971 I reported about a so far unknown parting agent Betaine. This recipe I got from Hermann Wirth (retired INTDS member) from Heidelberg, who had used this parting agent for some years, but never had published his idea. The proceedings and with them my paper [1] were printed in 1972. It was entirely due to the late Ed Kobisk that target makers all over the world got the chance to communicate with each other and to publish in the well known journal "Nuclear Instruments and Methods". This conference was the real hour of birth of the INTDS. It had very many highlights and among them, there was a paper about the structure of parting agents [2] which demonstrated that the crystallite size and structure is responsible for the floating success and mechanical strength of the target foil. Especially large crystallites and sharp edges reduce the success rate. For these demands Betaine offers advantages, the corrugated structure has practically no sharp edges. That is why it is an excellent parting agent especially for very thin foils e.g. carbon stripper foils. Unfortunately it can not be applied in high humidity summer periods, because it is hygroscopic. That is why we are searching for other organic compounds which show similar structures but being not so much hygroscopic. So far without success.

The recipe for the parting agent we used bases on seven volume parts of a concentrated solution of betaine mixed with one volume part of a concentrated sucrose solution. When preparing the concentrated betaine solution it is always underestimated how much of the betaine material must be added to the water to get a concentrated solution, which means we add up with too much of the concentrated betaine solution. Betaine is not cheap which means wasting it if starting with more water than needed. It cannot be stored unchilled for longer periods due to fermenting by yeast fungi.

We normally start with 70 ml distilled water in which ≈ 170 g of betaine leads to a concentrated solution of ≈ 210 ml. Unfortunately you never know how much of the pure betaine has changed into betaine mono hydrate due to humidity. In the worst case ≈ 60 ml of distilled water would be sufficient for a concentrated solution. In case of the sucrose we start with ≈ 20 ml distilled water and fill in sucrose without weighing it until a ground deposit remains. This is easier and sucrose is cheap.

References

- [1] P. Maier-Komor, Nucl. Instr. and Meth. 102 (1972) 485
- [2] D. N. Braski, Nucl. Instr. and Meth. 102 (1972) 553