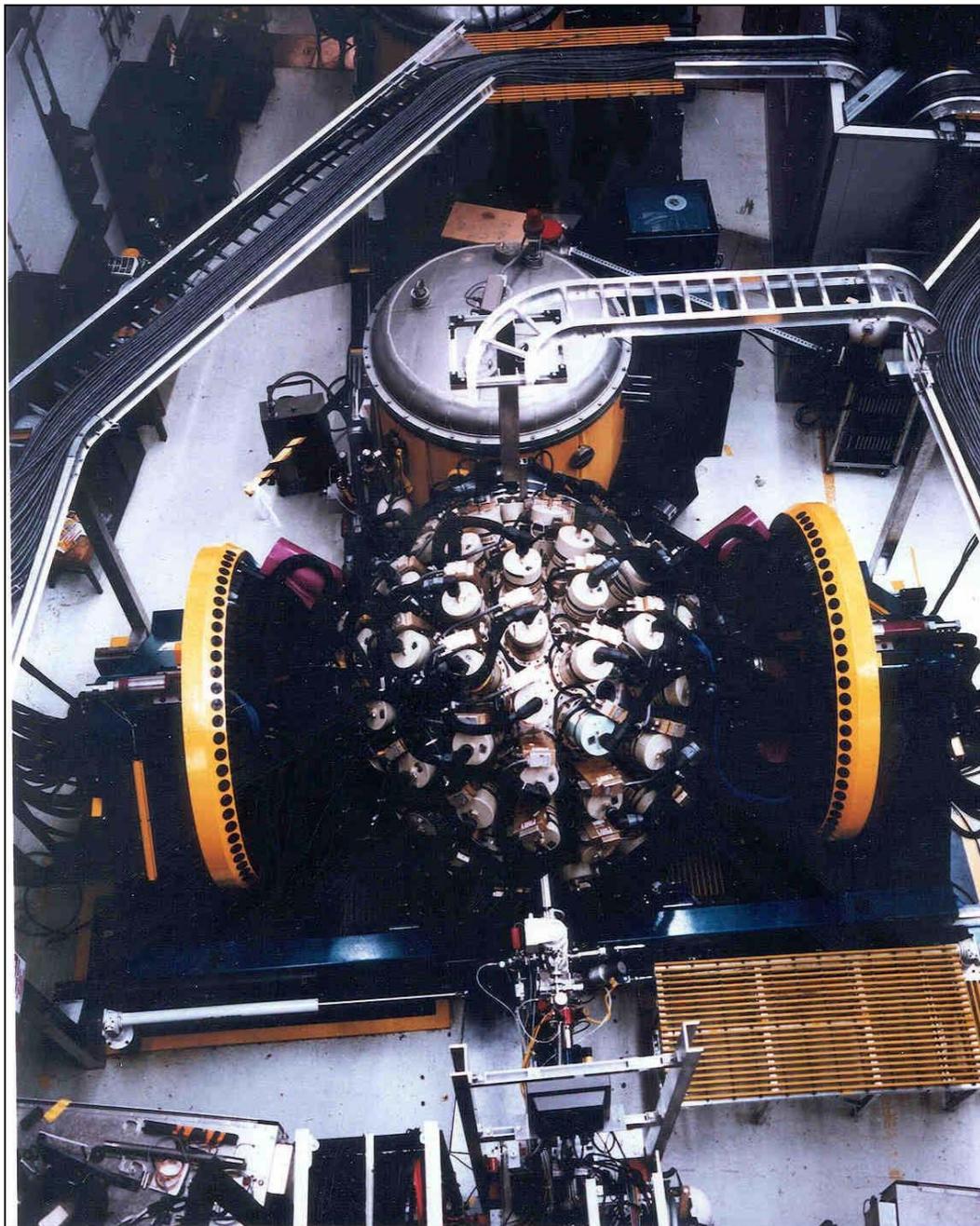


# INTDS NEWSLETTER

**International Nuclear Target Development Society**



January 2004  
Volume 31  
Number 1

# CONTENTS



www.intds.org

Editor's Note	3
News of the INTDS	4
Technical Contributions	
<i>PVP as a Release Agent for Aluminum Films</i> Joe and Joanne Heagney Micromatter Co.	8
<i>Preparation of self-supporting targets with thickness of less than 100 <math>\mu\text{g}/\text{cm}^2</math></i> Xu Guoji and Du Yinghui CIAE	9
<i>Two-Step Target Design Issues</i> W.L. Talbert TechSource, Inc.	11
<i>Automated Thickness Measurement of Thin Foils</i> Willi Hartmann, Birgit Kindler, Bettina Lommel, Jutta Steiner, Josef Klemm GSI	13
<i>Laboratory Activity Report</i> Stanislav Vesnovskii RFNC-VNIIEF	15
INTDS Membership List	19

## Cover Photo

GammaSphere, the world's most sensitive gamma-ray detector for nuclear physics research, has returned to Argonne after a two-year stay at Lawrence Berkeley National Laboratory. GammaSphere is a high-resolution gamma-ray "microscope" designed to help answer fundamental questions about the structure and behavior of atomic nuclei, and study rare and exotic nuclear processes. The 10-foot-tall, 14-ton device has 110 germanium detectors that are cooled with liquid nitrogen.

EDITOR  
John P. Greene  
greene@anl.gov

DESIGN AND  
LAYOUT  
Janelle Neubauer

SUBSCRIPTIONS  
Bill Lozowski  
lozowski@iucf.indiana.edu

ADVERTISING  
John P. Greene  
greene@anl.gov

# EDITOR'S NOTE

Welcome the new look of the INTDS Newsletter, we hope you enjoy it.

This issue is my first as Editor and heralds the return of the Newsletter to Argonne National Laboratory where it was first begun by George Thomas back in 1974!

With the advances in electronic publishing, we invite any interested members to select distribution of this or future issues of the Newsletter as a “.pdf” file via email. Let us know your wishes. Plans are also underway to post back issues for download on the INTDS website (minus the Membership Lists), making “reprints” of submitted articles instantly available! In the future, archived Volumes may become available on CD-ROM.

I would like to thank past editor, Anna Stolarz for all her help and encouragement. We also need to acknowledge the Physics Division of Argonne National Laboratory for their generous support in this effort. Finally, without the wonderful assistance of Janelle Neubauer, I wouldn't get anything done!

John P. Greene  
Editor

# NEWS OF THE INTDS

## **ANL 2002 INTDS Conference Wrap-Up**

*John P. Greene – Conference Chairman*

*Physics Division, Argonne National Laboratory*

### The Conference

The 21<sup>st</sup> World Conference of the International Nuclear Target Development Society (INTDS) was held on November 4-8, 2002 in Argonne, IL USA, hosted by the Physics Division of Argonne National Laboratory. Over 60 participants attended from 15 countries with over 40 invited and contributed talks in 8 sessions. Additional foreign participants were anticipated but could not attend due to tighter security restrictions, which resulted in long lead times needed for the granting of visitor visas.

Sessions covering a wide range of target topics were organized, each preceded by a plenary talk from an invited speaker (ANL, Argonne, USA and NIST, Gaithersburg, USA and GSI, Darmstadt, Germany) presenting an general overview relating to the session subjects. Topics included, thin film preparation and characterization, isotope separation, and novel methods of target fabrication with sessions emphasizing high-power targets for the next generation radioactive ion accelerators and stripper foil applications.

During the conference banquet, held at the Argonne Guest House, INTDS career achievement awards were presented to long-time members, Pete Gobby (retired) of Los Alamos National Laboratory, Hans Maier of the Universität München and Joe Tracy (retired) of Oak Ridge National Laboratory for their dedicated service to the Society and their many contributions of target preparation techniques.

I would like to thank the Organizing Committee for the success of the conference, the INTDS reviewers for many fruitful discussions resulting in many excellent contributions to the Proceedings.

And, finally, many thanks are due to the efforts of the Physics Division and the Argonne conference staff for their hard work.

### The Budget

According the records kept by the Physics Division for the various categories related to the conference, at the end of FY '03 we were over budget by \$513.00. This money was drawn from the account set-up for the Proceedings. Currently we have \$4487.00 set aside for publication in NIM. We don't as yet have the final amount needed from Elsevier.

### The Proceedings

Exactly a year to the day, the INTDS Proceedings from the 2002 Conference has been delivered to NIM. Disks containing all of the electronic text and reviewed manuscripts were sent out November 4th followed by the final version hard copies and original figures on November 8th, 2003. The expected date of publication will hopefully be sometime in late March of this year. For both myself and my co-editor Peter Maier-Komor, we wish to extend our gratitude to all the hard work put in by the Members of the Board and especially all the Reviewers for once again publishing excellent Proceedings!

Jan. 6, 2004

Dear Members,

This is to inform you that I have stepped down after serving as your Corresponding Secretary-Treasurer since the Society's start over 27 years ago. The duties have been graciously assumed by Bill Lozowski at Indiana University Cyclotron Facility. All correspondence concerning and payment of dues, general INTDS business, and purchase of past proceedings should be directed to Bill.

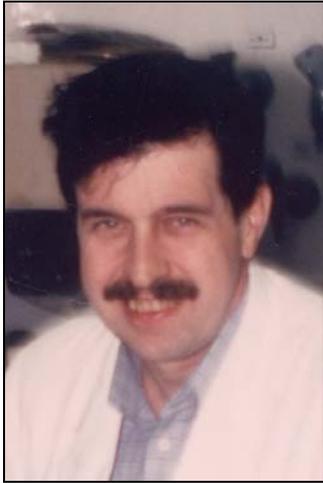
My husband, Joe and I recently moved our home and business, MicroMatter Co. from Deer Harbor, WA on Orcas Island to the mainland at Arlington, WA. We decided that this was an appropriate time for us to cut back on outside activities. Settling into a new home and setting up our business in a new facility is a big undertaking requiring most of our time and energy.

I have greatly enjoyed my tenure as a member and officer in the Society for these many years and have made many wonderful friends. Joe and I hope to continue seeing you at future INTDS gatherings.

Warm regards,

Joanne Heagney  
18218 – 18<sup>th</sup> Ave. N.W.  
Arlington, WA 98223  
U.S.A.  
Phone: 360-652-2574  
FAX: 360-654-0574  
E-mail: [jheagney@micromatter.com](mailto:jheagney@micromatter.com)

## Josef Klemm Retired from GSI



Josef Klemm 'Jok' retired from the GSI Target laboratory at the end of 2003 after producing heavy-ion targets for nearly 30 years.

In 1978 he attended the world conference of the INTDS in Garching, and from this date on he was a regular participant of the conference whenever it took place in Europe. Jok, a chemical engineer, became a specialist on radioactive targets, ion-beam sputtering and the reduction of rare-earth materials. He prepared an enormous amount of targets, he very rarely stated, that something cannot be done.

He decided to leave us early to have enough spare time and energy for his favourite hobby: Travelling.

We did not let him go easily; we are going to work hard to fill his post, but we allow that he has earned his retirement after working for more than 42 years, and always working hard for the tailor-made solution. We wish him a lot of time and leisure for the realisation of his plans.

Bettina Lommel  
Target Laboratory  
GSI

January 2004

## **Gervas Hinn Retires**

Jerry is happy to inform us of his full retirement from The University of Washington Isotope Lab after 36 years of service.

He wishes to send fondest greetings to those members who remember him and greetings to those members he hasn't had the pleasure of meeting yet.

For those wishing to contact him, the following is his new address:

Gervas (Jerry) Hinn  
1543 NW 58th St.  
Seattle, WA 98107  
USA

E-mail: [gmhinn@comcast.net](mailto:gmhinn@comcast.net)  
Fax: 206-782-8943  
Tel: 206-782-8943

## **CAARI 2004 (Denton Conference) will be in Ft. Worth**

CAARI 2004: 18th International Conference on the Application of Accelerators in Research & Industry, October 10-15, 2004, Ft Worth, TX, contact Margaret Hall at 940-565-3250 or [hall@unt.edu](mailto:hall@unt.edu) for information.

J. Greene from the INTDS will be organizing an Invited Poster Cluster Session in Targets. Contact J. Greene at 630-252-5364 or [greene@anl.gov](mailto:greene@anl.gov) for information.

The posters in this cluster will be displayed together during the designated poster session. Also, participants will be allowed a few minutes at the end of an appropriate oral session to describe their poster.

The invited poster participants are treated exactly the same as invited oral participants. The official invitation from our office should be sufficient to justify your travel funds to give an invited paper at CAARI. Invited poster papers will be reviewed and those accepted by the referees, will be given five (5) pages in the Proceedings (NIMB), which is the same for invited oral presentations.

# TECHNICAL CONTRIBUTIONS

## **PVP as a Release Agent for Aluminum Films**

Joe and Joanne Heagney  
Micromatter Co.

Responding to Peter Maier-Komor's call for other release agents, which he made in his last Newsletter article on betaine/sucrose as a release agent, we feel that we should mention the use of PVP as a release agent.

Many years ago Lazlo Csihas informed us that he had good success with the use of PVP (polyvinylpyrrolidone ( $C_6H_9NO$ )<sub>x</sub>) as a release agent for aluminum foils. This organic material is (has been) widely used as an ingredient in hair spray and other hair control products. It is slightly water soluble, very soluble in organic solvents and somewhat resistant to heat in vacuum. Since aluminum is attacked by many of the salts commonly used as release agents, the use of an organic compound eliminates the ionic attack when floating the film.

Our procedure for use is as follows. A solution of PVP in methyl alcohol is prepared in a concentration of 1 gram PVP to 75 ml MeOH. Clean glass microscope slides are dipped in this solution and allowed to dry. (while draining the accumulation at the bottom of the slide is absorbed with a tissue to avoid a large buildup there. The dried slides are used as substrates and Al evaporated using a resistance heated tungsten filament. After scribing the film to the desired shape and size the foil is floated in warm to hot water and picked up on frames in the normal way. Because of the poor solubility, the release is slow and the higher temperature of the water is important to speed up the process. Since the PVP coatings are so easy to prepare, we have no experience in storing coated slides and we use them shortly after preparation. The solution has been stored for years in a closed container.

The foils produced using PVP are smooth and shiny and are not textured as in the case of betaine/sucrose. While the PVP film does not appear to be as uniform as an evaporated film it works and as long as the PVP is not degraded, should be useful for other materials.

## Preparation of self-supporting targets with thickness of less than 100 $\mu\text{g}/\text{cm}^2$

Xu Guoji Du Yinghui

Department of Nuclear Physics, CIAE, Beijing 102413 P.O.Box 275-62, China

Low energy nuclear reaction studies require thin self-supporting targets in order to get optimum resolution. Resistance heating and electron beam bombardment were used to produce them with source-to-substrate distance of 10-15cm. Betaine-coated microscope slides worked as substrates. It was found that substrate heating was not necessary at all when our standard parting agent, a mixture of betaine monohydrate and sucrose was used. This resulted in strong, little stress foils. Even cases like Ni, Cr and Fe, which normally cause major problems, could be handled easily. A list of tested targets is compiled in table 1.

Table 1. Self-supporting targets < 100 $\mu\text{g}/\text{cm}^2$

Element	Thickness $\mu\text{g}/\text{cm}^2$	Element	Thickness $\mu\text{g}/\text{cm}^2$
Be	20	Ag	40
B	45	In	45
C	7	Sn	40
Al	5	Au	40
Si	25	Bi	50
Sc	40	Gd	50
Ti	25	Tb	65
V	35	Dy	65
Cr	90	Ho	60
Mn	60	Er	90
Fe	75	Tm	95
Co	45	Yb	75
Ni	40	SiO <sub>2</sub>	25
Cu	35	ZnS	65
Ge	50	GaO <sub>2</sub>	50
Pd	65	ZrO <sub>2</sub>	90

We found that the calibration curves of optical transmittance of some metal films were particularly useful for thickness determinations. The measurements were carried out using a visible light spectrophotometer. Reference thicknesses were determined by weighing measured areas of foils that were produced by resistance heating. The results are shown in Fig. 1 and Fig. 2.

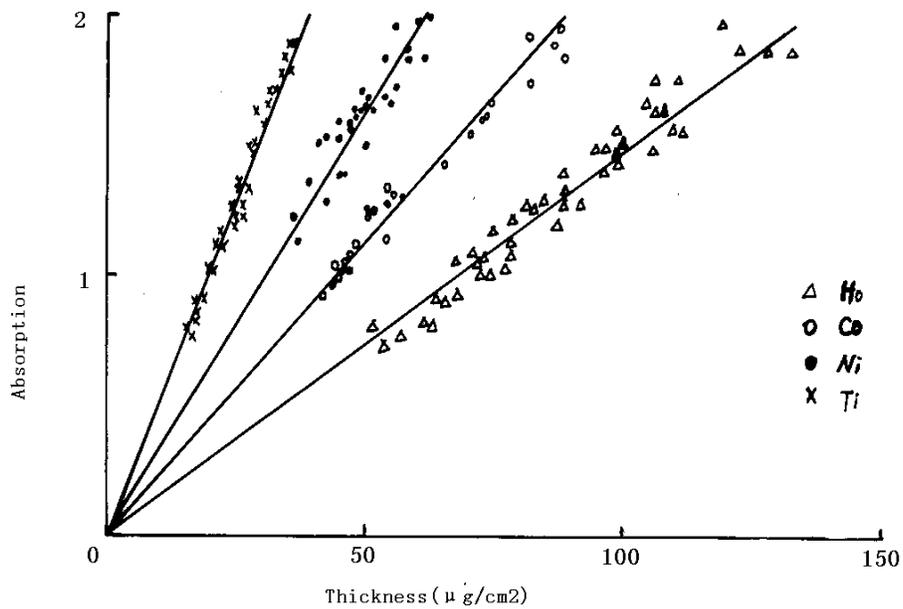


Fig. 1 Thickness calibration curves for holmium, cobalt, nickel and titanium foils as a function of their absorption of light at 680nm.

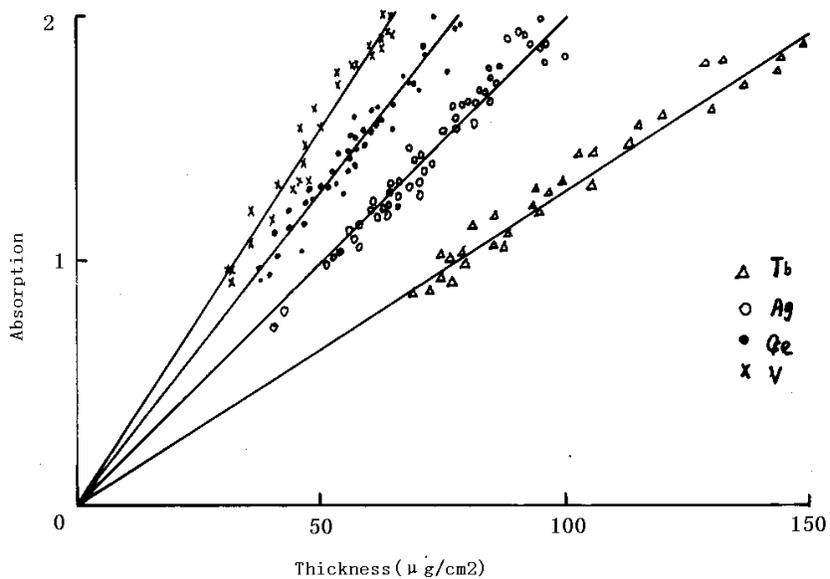


Fig. 2 Thickness calibration curves for Terbium, silver, germanium and vanadium foils as a function of their absorption of light at 680nm.

[1] J.C.Gursky, Proc.10th World Conf of the INTDS, Rehovot, Israel, 1981,P.83.  
[2] C.P.Bonetti, P.M.Guay, J.Jouanigot and J.Kwinta, Proc.4th World Conf of the INTDS, Argonne Natl.Lab, ANL/PHY-84-2, P101.

## Two-Step Target Design Issues

W. L. Talbert  
TechSource, Inc.  
Santa Fe, NM

### Two-Step Target Concept

The two-step target concept was introduced to address the problem of interference with production of neutron-rich fission product activities by isobars produced from high-energy spallation processes in fissionable target material. Through experiments at ISOLDE [1] it has been shown that, through the use of a primary target, or “converter,” to produce spallation neutrons which then illuminate a secondary target of fissionable material, the problem of isobaric interference can be overcome. The concept has been most clearly introduced by Nolen, et al. [2] as an efficient coupling of an annular secondary target surrounding a central cylindrical primary target.

The issues presented here are those encountered in a design effort to develop a two-step target for a proof-of-principle experiment at the ISAC facility [3] employing a cylindrical, solid primary target that is water cooled coupled to an annular coaxial secondary target of U/C material.

### Primary Target Issues

The two-step target concept incorporates a primary target exposed to the incident light-ion production beam (for the ISAC test, with 500-MeV protons up to 100  $\mu$ A intensity). There are three purposes for the primary target: (1) to be a source of neutrons (of energy below 20 MeV) to illuminate the secondary target; (2) to dissipate the energy deposited by the production beam and allow the secondary target to avoid the destructive effects of direct high-intensity irradiation; and (3) to confine any radioactive products from direct production beam interactions.

The issues in design of the primary target are mainly associated with the first two items. The rate of neutron production (or conversion) is important, to maximize the production of fission products in the secondary target. For this purpose, the primary target should be of high-Z material and dense, in order to achieve maximum neutron multiplication from the primary production beam in a small length. High-density, high-Z refractory materials such as tantalum, tungsten, rhenium, or even a liquid target of mercury are candidates.

The cooling of the target is important at high production beam intensities, so knowledge of the material thermal properties (especially thermal conductivity) is critical in the design. An added issue is the presence of mechanical stress induced by the large temperature gradients (in the case of liquid coolant use at “normal” temperatures). Typical design approaches indicate the need for stress relief features, such as segmenting the target.

A design has been achieved for the ISAC test target employing a rhenium primary target of length 6.7 cm and radius 1.145 cm, and with four longitudinally-coupled tubes for water coolant imbedded to a radial depth of 0.7 cm. For stress relief the target design incorporates four longitudinal slots between the coolant tubes and four axial segments. The relatively low thermal conductivity of rhenium dictated careful attention to the pathways for removal of the **approximately 22 kW of deposited heat** (for an incident proton intensity of 100  $\mu$ A), especially in the vicinity of the coolant tubes. This primary configuration results in a neutron production rate (entering the secondary target) of 4.3 neutrons per incident proton. At higher proton energies, this n/p ratio will increase substantially.

## Secondary Target Issues

Secondary target issues are simply stated as (1) size (to allow fission products to effuse from the target structure efficiently), (2) fission rate (associated with the neutron flux distribution and target material density) and (3) temperature distribution. For the first two issues, relatively high secondary target material densities are advantageous, provided that the release of the produced radioactivities is acceptable. For the ISAC target, a designed annular radial interval of 2.1 cm has proved to be quite efficient for production of fissions for target material density of about 5 g/cm<sup>3</sup>. The resulting fission rate is about 0.06 fissions per incident proton.

Production of secondary target components seems not to be a large issue, except for the requirement that each piece of secondary target material be of consistent density and grain structure.

The third issue of developing the ISAC secondary target design with acceptable temperature distribution has proved to be a very vexing problem, largely because the energy deposition in the secondary target is small compared to that in the primary target and the prospect of heating the secondary target from the primary target is not possible along with the cooling imposed. The best solution, but difficult to conceive in the geometry assumed, is to externally heat the secondary target. The alternative is to contain the heat deposited from fission events (approximately 1.2 kW for the incident production beam intensity of 100  $\mu$ A) as efficiently as possible through multiple heat shields.

The temperature distribution within the target material is a direct consequence of the value for the thermal conductivity of the material and distribution of energy deposition from fissions. With high thermal conductivity (of the order of a few W/m<sup>2</sup>-K), the temperature distribution within the target material is reasonably flat around 1700°C, when six external heat shields are employed.

The most critical remaining issue for the secondary target material is to assure consistency of bulk and thermal properties within the target volume.

## Conclusions

This discussion assumes the use of finite element thermal analysis simulation, coupled with Monte Carlo beam interaction simulation. A design for the ISAC test target appears to be possible, but development and availability of suitable secondary target material have not yet been achieved. It is anticipated that the target test can be carried out before the end of 2004.

## References

1. R. Catherall et al., Nucl. Instr. and Methods B 204 (2003) 235
2. J. A. Nolen et al., Nucl. Phys. A 701 (2002) 312c
3. P. G. Bricault, M. Dombisky, P. W. Schmor and G. Stanford, Nucl. Instr. and Methods B 126 (1997) 231

## Automated Thickness Measurement of Thin Foils

Willi Hartmann, Birgit Kindler, Bettina Lommel, Jutta Steiner, Josef Klemm,  
Gesellschaft für Schwerionenforschung (GSI), Planckstrasse 1, 64291 Darmstadt, Germany

On the INTDS Conference in 2000 in Antwerp we presented the set-up of a target scanner for the automated thickness measurement for targets and degraders [1]. The target scanner was designed for measuring large and massive parts with a high accuracy, parts that can withstand mechanical strain acting on both surfaces without support. It consists of a xy-stage mounted on an optical table, two optoelectronic length gauges, the control and a PC, as shown in Fig. 1.



Fig.1: Computer controlled target scanner

Recently, we upgraded the target scanner set-up for measuring also the thickness of thin foils position dependent. For this purpose, we constructed a special sample holder where the foil is measured together with a support plate. The foil is pressed homogeneously on the support plate with a raster plate made of stainless steel where the upper measuring tip fits through the holes. The sample holder with the stack of the support plate, the foil to be measured and the raster plate is depicted in Fig. 2. This sort of thickness measurement is suitable for all foils that are hard enough to withstand the mechanical stress of the measuring gauge without visible deformation.

This support plate with a diameter of 90 mm is made of quartz with both large surfaces lapped to guaranty that both faces are plane and parallel to each other. In the first step the thickness of this plate alone, which is mounted in the sample holder in a fixed position, is

measured at all points that are defined by the raster plate. These values are stored to be later subtracted for each point from the measurement of the plate together with the foil of unknown thickness.

The variation in thickness of the quartz plate was  $1.2 \mu\text{m}$  from minimum to maximum thickness at an absolute thickness of  $5.86 \text{ mm}$ . For a typical Be-foil from Lebow Company which was specified as  $(20 \pm 2) \mu\text{m}$  the variation we measured really was up to  $4 \mu\text{m}$ . The thickness could be measured automatically to a high accuracy in a grid with  $9 \text{ mm}$  step size.

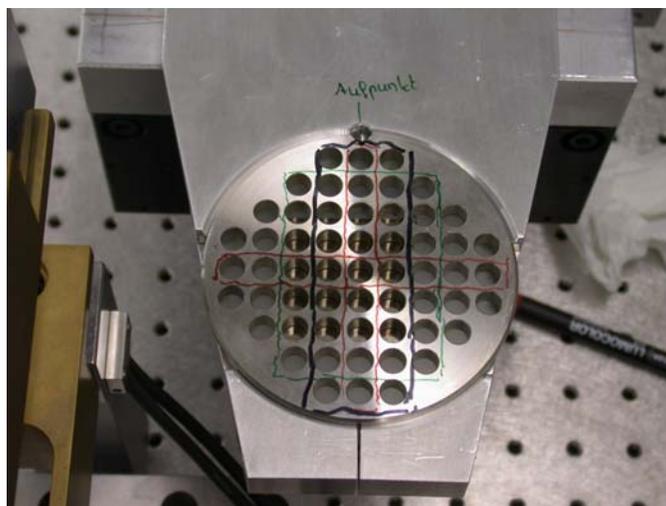


Fig.2: Sample holder for foil measurements with the stack of quartz support plate – Be-foil – raster plate

This information enabled the experimenters from the nuclear chemistry department to cut from the purchased Be-sheets their backing foils with a minimum thickness variation. The size of this variation directly influences the accuracy of their experiment.

Since our last report in 2000 we gained a lot of experience with the target scanner set-up and we especially learned about the important influence of deformable measuring tips on the accuracy of the absolute thickness determination. The theoretical accuracy of  $\pm 0.25 \mu\text{m}$  in thickness is only reflected in the measurement when non-deformable metallic tips are used which is essential for the measurement of thin foils as described here.

#### References:

- [1] B. Kindler, H. Brand, W. Hartmann, J. Steiner, J. Klemm, B. Lommel, Nucl. Instr. And Meth. A 480 (202) 160-165.

## Laboratory Activity Report

Stanislav Vesnovskii

International Program Coordinator & Manager

Russian Federal Nuclear Center-VNIIEF

Institute for Nuclear & Radiation Physics

Fax: +7-83130-45680

E-mail: vesnovskii@expd.vniief.ru

For more than 35 years there has been functioning in RFNC - VNIIEF a laboratory of electromagnetic separation of isotopes. S-2 mass-separator possessing radiation shielding is used in the laboratory activities. It provides the possibility of carrying out the works with high-activity actinide materials.

Today this laboratory is the only in the world that makes it possible to realize the works of this kind. The products of this laboratory enter the world market and the demand in them is steady. During the last four years there was achieved essential success in perfecting and stabilization of mass-separator field performance characteristics and radiochemical technologies used at the production of high-purity isotopes with unique potentialities as to enrichment. These works were performed within the frames of ISTC Project No1318 funded by USA and Norway.

These works were performed as preparatory activities for the realization of electromagnetic separation of the provided by US DOE mixture of heavy isotopes. The goal was to get highly enriched plutonium-244 to produce a new generation of standards used in the system of control over non-proliferation of nuclear materials and to reveal undeclared nuclear activities these works being performed by a set of IAEA Laboratories.

According to the terms of Contract No 2000-827 between IAEA and RFNC - VNIIEF there should be produced of a batch of plutonium oxide (mass-5g, 4.5 g by metal) and delivered to the customer 100mg of plutonium-244 of 99.6% enrichment and 1mg of plutonium-244 of 99.99% enrichment (after double separation).

One can get sufficiently complete information on the goals of the scheduled by us works on plutonium-244 production from article "Development of technology for high-purity  $^{244}\text{Pu}$  production by method of electromagnetic separation" by S.Deron, S.Vesnovskii that was published in NIM A438 (1999) 20-22. One should accept the fact that the achieved by today characteristics of S-2 mass-separator guarantee realization of the tasks set up by the Contract, however, a considerable mass of expensive material would be lost beyond retrieve.

Such characteristics as regeneration degree of the scattered in the facility material for its further introduction to separation process (85-90%) and extraction degree of the accumulated in the collector isotopes (up to  $\sim 100\%$ ) can be considered as maximal of those possible and, thus, acceptable. However, as in the accepted and used nowadays technology of isotopes electromagnetic separation, the working substance loaded to the S-2 separator ion source is trichlorides of actinide elements, the coefficient of material use in the ion source cannot in principle be high (on the average, not higher than 5 %).

Today we have substantiated the possibility of essential increase (by a factor of 2 or 3) of the coefficient of material use in the ion source. The realization of such possibility opens new spheres of using electromagnetic separation to produce highly enriched isotopes:

- possibility of buildup of the final product required amount at essential reduction of the required mass of initial material;
- possibility of carrying out the works in electromagnetic separation as applied to the use of radioactive specimens with high specific activity;
- essential reduction of time spent to electromagnetic separation and, thus, of labor output ratio of the works implemented;
- corresponding reduction of the cost of the produced unit.

One more revolutionary point in perfecting technology and engineering characteristics of the process of electromagnetic separation is the transfer to using high-temperature ion source applying initial product in the form of metal as working substance what considerably affects the ionization characteristics of the source and notably increases the yield of isotope ions from it.

The given work could be a natural development and continuation of the realized developments and an subject of the new ISTC Project immediately using the technological and hardware base occurred as a result of fulfilling the works on Project No 1318. Specific experience in using metal form of initial substance was gained during trial experiments carried out in the middle seventies. Unfortunately, the experiments were not continued and developed further on.

The contents of activities on the new Project can be as follows:

- development of technology of producing separated material in metal form at low initial amounts;
- development of design of high-temperature version of ion source permitting the use of initial material in metal form;
- modification of the facility power blocks and schemes of ion beam stabilization;
- perfection of the technology of the process conduct and development of mass-separator assemblies ensuring quick adjustment of ion beam and optimal introduction of ions to the boxes of isotope collector;
- carrying out of reference experiments to separate mixture of isotopes of different actinide elements for the purpose of selecting optimal methods of electromagnetic separation conduct.

Basing on the estimates the realization of the given Project will require 2-2.5 years at the total level of funding equal to 250-270 thousand dollars. As applied to buildup of plutonium-244 for IAEA of the substance provided by DOE the realization of the proposed new technology will make it possible to increase the amount of produced plutonium and correspondingly reduce the expenditure of the expensive initial material. As applied to multiple tasks of fundamental physics and other applications of unique by isotopic enrichment materials, the potentiality of producing materials for heavy targets in the experiments on synthesis of new transactinides should be specified (the works on new transactinides synthesis being in progress in a set of countries) or producing of highly enriched isotopes of medium masses should be noted.