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CONTENTS

Cover Photo

Photo coutesy of Dr. Bettina Lommel and Dr. Birgit Kindler, GSI (see accompanying article)

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EDITOR'S NOTE

This issue is woefully late in going to press. I can make no excuses, the fault lies with your humble editor and his ability to prioritize a hectic schedule. My sincere apologies to all of our members, especially those contributing to this Newsletter. I am leaving the date designated as January 2005 as I wish to keep the current twice yearly publication we've been used to.

We again 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. Back issues are now posted on the INTDS website for download (minus the Membership Lists), making "reprints" of submitted articles available via the web. As time goes by we will compile archived Volumes and make them available on CD-ROM.

I would like to acknowledge the Physics Division of Argonne National Laboratory for their support of our Newsletter and my special gratitude to Janelle Neubauer for her wonderful assistance over the years.

John P. Greene
Editor

Errata *From the previous Newsletter 31.2;*

An Update from GANIL *(should include as Authors);*
Christelle Stodel, Georges Frémont, Charles Spitaëls and Gérard Auger
GANIL

INTDS Award Presentation to Joanne Heagney at the 22nd World Conference in NIST, Gaithersburg, Maryland, Oct. 20, 2004

The INTDS is pleased to recognize Joanne Heagney with an Award of Recognition for contributions and service to the Society and science. Unfortunately she could not receive her award personally, due to a present difficulty with travel.

You may ask why I, the past president (Peter Maier-Komor) presented this Award. The reason is simple, because I have known her longer than any active member in the INTDS. The first time I had met the attractive young lady was at the Third International Symposium on "Research Materials for Nuclear Measurements" in Gatlinburg, Tennessee in October 1971. There the seeds of the INTDS were sowed thanks to Ed Kobisk (Oak Ridge Nat. Lab.) and Karl Lauer (CBNM Belgium).

Joanne earned her BS in Chemistry at the University of Washington in Seattle. During graduate work there, she was hired by the Nuclear Physics Laboratory in 1962 to develop targets and then later lithium-drifted silicon detectors. When the target work became the more interesting, challenging and time consuming of the two, she trained another person to make these detectors. During 11 years as a member of the research staff at the Nuclear Physics Laboratory, her abilities increasingly drew requests from outside physicists. As a consequence the team of Joanne and Joe Heagney founded "MicroMatter" company in 1968 to respond fast, competently and without bureaucratic hindrances to these requests. They crowned their business relationship by marriage in 1969. This successful small business quickly became well known for high-quality targets, research samples and, presently, standards for X-ray florescence. Coincidentally, and unknown to Joanne for some time, it was a NIST reference to a 1979 paper of the Heagneys that initially led many XRF clients to "MicroMatter". The paper detailed procedures to produce these thin films. To date, she supplies 63 elements as standards: from lithium to uranium. Most are used around the world to calibrate instruments that test for lead in paint, contaminates in air and water, coating thickness measurements, and related issues of high concern.

Her other papers in INTDS publications are wide in scope: "Preparation of isotopic accelerator targets," "Thin film X-ray fluorescence calibration standards" "Evaporation of high vapor pressure materials," "Reduction techniques for isotopic materials," "A simple efficient method for reducing small quantities of zinc oxide," "An improved electrostatically focused electron gun for high-temperature evaporations," and even "A quick bell jar repair method." Along with this body of work, she has been a colleague who often provided to others suggestions that made unruly technical problems dissolve straightaway.

In 1977, she co-authored with Hans J. Maier an extended entry in The Encyclopedia of Applied Physics titled, "Targets for Particle Accelerators." Characteristically, she, Joe and Hans contributed to the INTDS the funds earned from that endeavor.

Joanne's commitment to the establishment of a community of target makers began in Gatlinburg in 1971 as mentioned before. She was one of the original founders of the INTDS and accepted the lead role to help draft the bylaws and incorporate the Society. Most admirably also, she served until December of 2003 as the corresponding secretary-treasurer. For several years, she served as both corresponding secretary-treasurer and recording secretary.

The Society has indeed benefited from her competence and dedication. Thank you, Joanne, for so many years of exceptional service which even does not end now. Happily she is still available for advice by phone or e-mail, and for reviewing the INTDS conference proceedings to be published in "Nuclear Instruments and Methods in Physics Research".

Peter Maier-Komor, INTDS past president (2003 - 2005)

INTDS E-Mail Mailing List

Status Report, January 2005

The INTDS e-mail mailing list has just completed it's second full year in operation. And with the exeption of a few initial problems seems to be working well for most enrolled members. Membership has grown to 20 members. List volume is very low, with the record being only 20kilobytes for 4th quarter, 2004.

One of our primary problems had to do with members selecting the digest option on sign-up. This option aggregates the messages until a certain file size is reached, and then sends a single message containing all messages posted to the list in the interim. This can be a blessing in a high-volume list; however, with our volume levels, this meant a member would receive a message about once every 2 years. Hardly an effective tool for timely communications! To prevent this, I have disabled the digest option for all existing members and removed it as an option for subscribing members. Recently, all members who had been signed up with the digest option received their first and only digest message containing all posts since list inception. This was an artifact of the software and could not be avoided. All members should now receive posts as they are sumitted.

Another difficulty some members have had involves multiple e-mail addresses. The list software acknowledges membership by e-mail address. This means that if one attempts to post to the list from an alternative address, the post will be held for authorization by the list administrator, which can lead to a delay in posting. The sender will typically receive a message explaining that this had occurred. Members may change their personal information, incluing e-mail address, as well as subscribe and unsubscribe from the info page:

https://lists.fsu.edu/mailman/listinfo/intds

Something members may find usefull is to enable the password reminder option. This will generate a monthly reminder message that is sent to the address of record and contains the member's password and other information. Simply go the the URL above, login and select the **Unsubscribe or Edit Options** button. This monthly message may help remind members which e-mail address they used to subscribe. One may also choose to subscribe multiple times with different addresses. Then by using the Mail Delivery option, delivery to the additional address can be suspended. Thus one can post from any address without having to endure multiple entries in their inbox.

Finally, I'd like to encourage all INTDS members to join the mailing list. Please contact me if you have concerns about privacy, security, or the software in general.

Sincerely,

Powell E. Barber
Florida State University

CAARI 2004 (Denton Conference) Ft. Worth, TX

John Greene attended the CAARI 2004: 18th International Conference on the Application of Accelerators in Research & Industry, October 10-15, 2004 in Ft Worth, TX, and organized an Invited Poster Cluster Session on Targets. This PA - Poster Session – Atomic Physics, IBA, Medical, Security, Teaching, & Accelerator Technology was held Monday evening.

There were five posters in our cluster and were displayed together during the designated poster session.
PA77 – Neutron Generator Targets by Carole Monnin
PA78 – Large Area Isotopic Silicon Targets for Astrophysical Reaction Rate Studies in ^{26}Si by John P. Greene and Georg P.A. Berg.
PA79 – Advanced Targetry with Ultra-thin Diamond-like Carbon Foils by Vitaly Liechtenstein, et al. (This poster was missing and was substituted with Target Preparation by Paul Morrall.)
PA80 – High heat flux accelerator targets cooling with liquid metal jet impingement by Ido Silverman, *et al.*
PA81 – RFI Linacs for Proton, Deuteron, and Heavy-Ion Applications by Donald A Swenson.

Also, participants were allowed a five minute presentation to describe their poster in the CF - Oral Poster Session – Accelerator Technology, IBA, & Microprobes held on Tuesday morning. The invited poster participants are treated exactly the same as invited oral participants. Invited poster papers will be reviewed and those accepted by the referees, will be given four (4) pages in the Proceedings (NIMB), which is the same for invited oral presentations. These Proceedings will be published by Elsevier in May, 2005.

Dear colleagues,

For some experiments with 13C we bought some 13CH2 from Campro.
However this material behaves total different from “natural” polyethylene.
The prepared material is very brittle. It is impossible to make a 2mg/cm2 (2x2 cm2) target from this material in the usual way. I assume that the polymerizing grade is too low.
I usually make the thin PE and C2D4 targets in the following way:
Boiling xylene with dissolved PE powder is poured on a SS plate.
After the xylene has been evaporated the SS plate is heated at the backside until the PE melts.
Immersing the hot SS plate in cold water results in a nice polyethylene foil.
Does anybody knows how to prepare the 13C polyethylene?
Thanks in advance.

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To INTDS members and Colleagues:

A Happy New Year 2005 !

The 23rd world conference of the INTDS will be held at the KEK, Tsukuba, Japan, 2006.

The conference will be tentatively 5 days in October 2006.
We wish cordially you to participate in the conference and present your work.
A detailed announcement, plans and call for papers will be issued later in the year.

With best regards,

Isao Sugai 05/1/19

TECHNICAL CONTRIBUTIONS

New Evaporation Set-Up for Uranium Compound Targets

Willi Hartmann, Annett Hübner, Birgit Kindler, Bettina Lommel, Jutta Steiner
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Introduction: In the past, thin uranium fluoride targets in the form of UF_4 on carbon backings were applied for heavy-ion experiments repeatedly. With this compound targets we had several problems: UF_4 had to be evaporated on thick carbon substrates of about 45 µg/cm². The targets were mechanically very fragile and showed heavy sputtering in the beam. The durability of the targets upon irradiation was generally short. For the heavy-element synthesis at GSI, targets of lead, bismuth and their compounds were applied successfully in cold-fusion reactions, where a low-Z projectile interacts with a target nucleus of lead or bismuth, respectively [1].
In Dubna heavy-element synthesis was performed successfully with hot-fusion reactions, where a ^{48}Ca-beam interacts with actinide targets [2].In a recent experiment at the BGS in Berkeley [3] with the reaction ^{48}Ca on ^{238}U the Dubna data could not be confirmed.
With a ^{48}Ca beam on ^{238}U targets at GSI, these experiments could be verified. Out of the actinide targets to be considered ^{238}U is the only target that can be prepared according to safety regulations in the current radioactive target laboratory at GSI.
For this experiment a great number of targets of ^{238}U in a good quality is needed. To prepare high quality targets a new evaporation apparatus was set up. The target production has started in September 2004. A first test experiment with beams of ^{12}C and ^{51}V is just completed.

Requirements for the $^{238}UF_4$ production: Metallic uranium is not stable in air, as it oxidizes very quickly. Metallic uranium targets therefore require for a load lock at the recipient, a safe transport in a water-free and oxygen-free atmosphere and a load lock at the target chamber as well. Suitable uranium compounds as a substitute are UF_4 with a melting temperature of 960 °C, UO_2 of 2827 °C, and UC of 2300 °C. While UF_4 can be evaporated thermally, UO_2 and UC targets can only be produced with an electron beam gun or by magnetron sputtering. To evaporate expensive, enriched or radioactive material with an electron beam gun is not feasible because of the amount of material needed at a fairly low yield. So an evaporation set-up with a thermal evaporation for UF_4 and a magnetron for UO_2 and UC was needed. A substrate heating was wanted too, after the good experiences we had with compound targets on heated backings in the case of Pb and Bi compounds [4]. For the covering layer a resistance heating for carbon rods had to be included. For a target production in a radioactive laboratory a low-maintenance pumping system is sensible, so we went for a magnetically levitated turbo pump backed by an oil-free scroll pump. We decided for the modular high-vacuum coater TF 600© from BOC Edwards©. Equipment and vacuum chamber accessories were designed according to our requirements. Figure 1 shows the front-loading vacuum chamber with the evaporation wheel, the platinum crucible clamped to high-current feed throughs, and the substrate heater above.

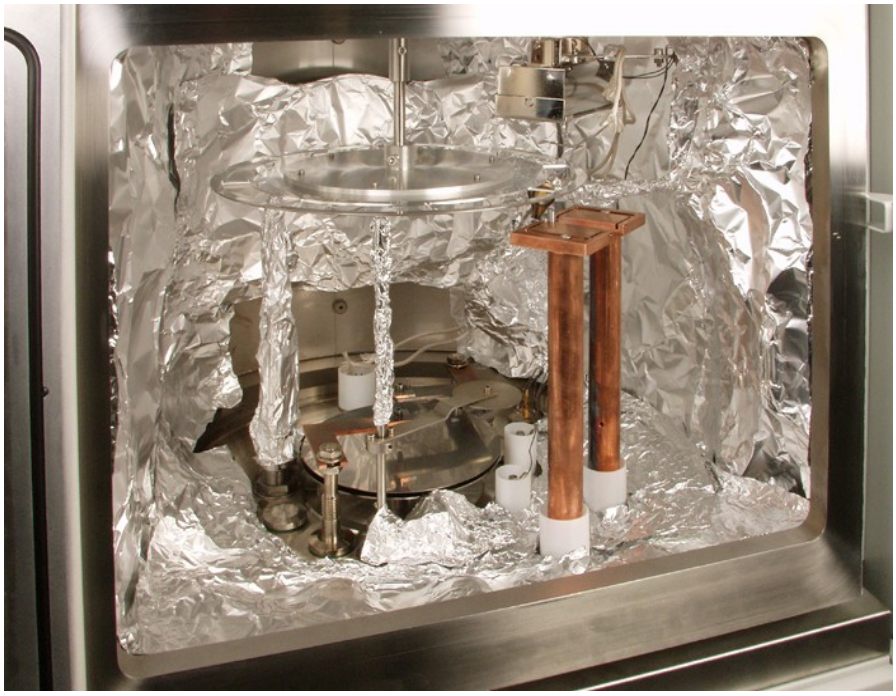

Figure 1: Open front-loading vacuum chamber of the high-vacuum coater TF 600© with the evaporation wheel, the platinum crucible clamped to high-current feed throughs, and the substrate heater above

Radioactive laboratory: The change of the evaporation set-up was done in close collaboration with the safety department. For the protection of the operator a suction cabin was installed around the evaporation set-up with curtains in front of the recipient door, as shown in the cover picture. The ventilation runs via filter into the radioactive outlet air. For a closed water cooling system, the cooling water for the machine is provided by a LAUDA© chiller WK1200©.

Experiment: We started with the thermal evaporation of UF_4 from a tantalum crucible on heated carbon backings with a thickness of 40 µg/cm². The evaporation started smoothly but after a while material often spurted out of the crucible, which damaged the targets. At the bottom of the crucible always remained remnant material which could only be evaporated by heating the crucible significantly higher. Probably there is a partial reaction of the fluoride with the tantalum crucible. As an alternative we also tested a platinum crucible. Though more power was needed to start the evaporation, the process itself ran very quickly without any splashing.
For both crucible materials we succeeded in depositing layers out of UF_4 with a thickness of 300 ± 30 µg/cm² according to the uranium. The targets were covered with a 10 µg/cm² carbon layer.
In a beam time at SHIP two UF_4 target wheels, one evaporated from the tantalum crucible and one from the platinum crucible, were tested with a ^{12}C beam and a ^{51}V beam. All targets were conditioned after mounting for the first time by increasing the beam intensity stepwise as this is known to increase the life-time of fluoride targets in

general. Since in 2005 a long beam time with a ^{48}Ca beam is scheduled, a vanadium beam was chosen as test beam for two reasons. Vanadium is a monoisotope so it is not necessary to use the ECR-ion source. That makes it easier to get the beam time for a test. And V is a beam heavier than Ca so that we can feel safe for the production run if the targets stand the test.
Since the cross-section of the reaction ^{51}V + ^{238}U → ^{289}115* is fairly low we could not expect to see any evaporation residues. Therefore after one day of irradiation of the UF_4 wheel evaporated from the platinum crucible the beam was changed to a C beam which was readily available. With the reaction ^{12}C + ^{238}U → ^{250}Cf* the quality of the irradiated UF_4 targets were tested. The measured rate of reaction products was as expected for intact targets. After another day the target wheel was changed to the one evaporated from the tantalum crucible, this time beginning with the C beam. The same rate of evaporation residues was observed; again a proof that the irradiation did not change the targets, at least as far as the quality for the heavy-ion reactions is concerned. The two UF_4 wheels prepared from the different crucibles performed similar in the experiment, so we will go for the evaporation out of the platinum crucible as this process seems cleaner, more reliable and better to control.

Outlook: Since the UF_4 targets showed a good durability in the heavy-ion beam, we will prepare UF_4 targets on a heated carbon backing by thermal evaporation for the beam time in 2005 for the reaction ^{48}Ca + ^{238}U to produce element 112 by hot-fusion reaction.

References:

[1] S. Hofmann and G. Münzenberg, RMP **72**, No. 3, (2002) 733-767

[2] Y. T. Oganessian et al., Phys. Rev. C **69**, 054607(9) (2004)

[3] K. E. Gregorich, http://www-w2k.gsi.de/future-she/

[4] B. Kindler et al., Nucl. Inst. and Meth. A, to be published

The Preparation of X-ray Filter Foils

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The X-ray Filter foils are widely used in laser physics. According the material and the thickness that users required, we developed four methods to prepare different foils and three methods to measure the thickness of those foils.

1. Preparation

1.1 Rolling

Rolling is a low consumption method to prepare metallic foils. With rolling[1] , we can obtain very pure foils. In general, the minimum thickness of rolled foil is about 1μm.

Table 1 Filter foils prepared by rolling

Element	Thickness (mg/cm^2)	Packing plate
Al	0.42	stainless steel,teflon
Ni	0.30	stainless steel
Fe	0.4	stainless steel
Ti	0.29	stainless steel
V	0.28	stainless steel
Zn	1.20	stainless steel,teflon
Cu	0.62	stainless steel
Mg	0.34	stainless steel,teflon
Mo	0.71	stainless steel
Y	0.36	stainless steel

1.2 Resistant heating

Resistant heating is applicable to the preparation of Cr, Al, Ni, Ti, Sn, Ag foils, But the foils' thickness is less than 1μm. The advantage of resistant heating is that it can produce even and large area foils, but it can't prepare refractory metal foils. In the process of heating, some metals such as Si,Fe,Co may erode the crucible ,which will pollute the foils.

Table 2 Filter foils prepared by resistant heating

Element	Y	Zn	Be	Fe	Cu	Ti	Al	Ni
Thickness (mg/cm^2)	0.3	0.6	0.2	0.4	0.1	0.3	0.1	0.2

1.3 Electron beam gun

In order to prepare the foils of refractory material, we use electron beam gun. The power of the gun is 3KW. The minimum spot size is 3mm diameter, which makes the evaporation of very

small amount of material possible. So the material that may alloyed with metallic crucible can be prepared by this way.

1.4 Carbon arc

Carbon arc[2] is specially applied to making carbon filter foils. The system we have set up can provide DC and AC carbon arc, which make preparation of large range thickness foils easy. The maximal thickness up to 0.5mg/cm^2 carbon foils can be prepared in one fabrication.

2. Thickness measurement

2.1 Balance weighing

There are two ways to measure the thickness by balance weighing. One is directly weighing the foils made by rolling. Another is weighing the Al film placed on the substrate before and after evaporation. The weight of the filter foil is obtained. Then we could calculate the thickness by dividing the area of the foil.

Because of the balance's precision, this method can not measure very thin foils.

2.2 Alpha particle thickness gauge[3]

This method can measure most of the foils, but it isn't applicable to measuring thicker foils just because the alpha particle's energy is limited. The diameter of the particle beam is 2mm, so it can measure the uniformity of the foil.

2.3 Spectrophotometer

The transmittance of monochromatic light is a sensitive method to determine the thickness of thin foils. The calibration curves of absorption of light at 680nm as a function of the filter foil thicknesses of C and Cu have been made, so it is easy for us to measure their thickness. Because of the 1.2×1.5mm spot of the light, the spectrophotometer is also can be used to measure the uniformity of filter foils.

Reference

[1]Xu.Guoji,Hao.Xiuhong.Some Special Techniques for Preparation of Nuclear Targets with Rolling. Atomic energy Science and Technology. 1996,30(1):62~64.

[2] Xu.Guoji,Hao.Xiuhong. Preparation of Carbon Foils with Carbon Arc Method. Atomic energy Science and Technology. 1996,30(1):73~76.

[3]Xu.Guoji,Meng.Xingjin.The Thickness Measurements of Targets with Spectrophotometer. Atomic energy Science and Technology. 1989,23(1):32~36