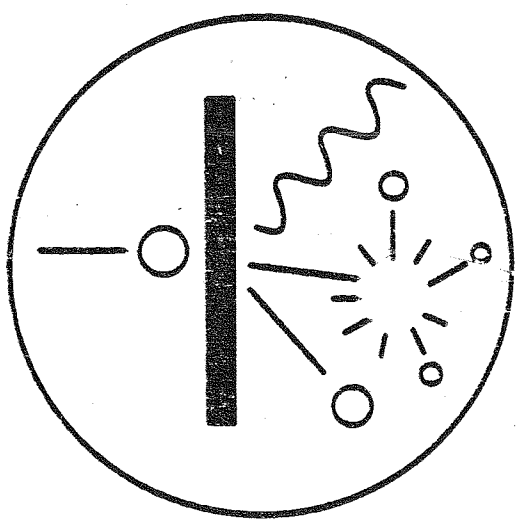
INTERNATIONAL NUCLEAR

TARGET DEVELOPMENT SOCIETY

NEWSLETTER



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CONTENTS

CONGRATULATIONS TO JAN VAN AUDENHOVE ON HIS RECENT PROMOTION

As President of INTDS, I want to convey on behalf of all INTDS members our congratulations to Jan Van Audenhove on his recent promotion. In his new position, Jan will be Division Head of Administration and Infrastructure at CBNM. Although he will not be directly involved in sample preparation activities, Jan has promised to continue to support INTDS activities.

Jan has been a very integral part of INTDS since it was formed in 1973 and has made significant contributions to the Society. During his tenure as president from 1983 until 1986, several changes were made which will result in INTDS becoming a stronger Society. His expertise in the area of sample fabrication and reference materials is known worldwide. Since 1974, Jan has been in charge of the sample preparation group at CBNM which is internationally known for its research and development efforts relating to target and special nuclear materials preparation.

I know that each of you join me in wishing Jan every success in his new position.

Harold L. ADAIR
President, INTDS

Editorial

Dear Colleagues,

I wish you and your families a Happy 1988, with good health and satisfaction in all your undertakings.

J. VAN AUDENHOVE
Editor

INTDS & IAEA-INDC Conference
"Heavy-Ion Targets and Related Phenomena"
Sep.5-9, 1988 — GSI, Darmstadt

November 1987

First Conference Call

14th World Conf. of the International Nuclear Target Development Society, organized in cooperation with the IAEA-International Nuclear Data Committee, at the Gesellschaft für Schwerionenforschung, Darmstadt, FRG, Sep.5-9, 1988

Methods for the preparation, characterization, application, and investigation of heavy-ion targets and other accelerator targets will be presented as well as techniques for the production and analysis of research and reference materials for fission processes and for neutron-dosimetry purposes. Metals, alloys, chemical compounds, stable enriched isotopes, and radioisotopes as self-supported layers or in the form of deposits on backing-foils will be included in the discussions. Target users will describe the influence of target and sample properties on accelerator research and nuclear data measurememements.

Program Committee of the INTDS

H. Adair, ORNL, Oak Ridge, USA
H. Folger, GSI, Darmstadt, FRG
P. Maier-Komor, TUM, Garching, FRG
J. Pauwels, CEC, Geel, BEL
G. Sletten, NBI, Roskilde, DEN

Program Consultant of the IAEA-INDC

K. Okamoto, IAEA, Vienna, AUS

Conf. and Progr. Committee Chairman

H. Folger, GSI, Darmstadt, FRG

Conference Secretary

Mrs. H. Weitzel, GSI, Darmstadt, FRG

Deadlines

Pre-Registration Dec.31, 1987
Hotel Reservation May 16, 1988
Subm. of Abstracts July 18, 1988
Subm. of Papers Sep.5, 1988

Exhibition

Display of appropriate equipment will be arranged upon request

Conference Language

English

Publication of the Proceedings

Invited and contributed papers will be published in Nuclear Instruments and Methods

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Stability of Carbon Foils on Orbiting Spacecraft

John O. Stoner, Jr.

University of Arizona, Physics Department, Building 81, Tucson, AZ 85721, and

ACF - Arizona Carbon Foil Co., Inc., 2239 E. Kleindale Road, Tucson, AZ 85719

Peters *et al.*[1] reported measurements of the erosion of various materials exposed to the atmosphere characteristic of low earth orbits, where atomic oxygen is the most important species. The erosion rate due to oxygen is sufficiently great to destroy a carbon foil 1000 Å thick in less than two hours. However, at altitudes of 200 to 600 km, the atomic hydrogen component also is measureable.[2] Atomic hydrogen reacts exothermally with carbon to form methane, ethane, and other hydrocarbons. It also reacts with boron and with silicon to form gaseous products. Thus it is of interest to estimate erosion rates due to the hydrogen component also.

Carbon-coated mirrors and carbon-metal multilayer coatings are being developed for x-ray-mirror applications.[3] Unbacked carbon thin films are used as ultraviolet[4] and x-ray[5] filters, and for components of particle detectors in space-probe applications.[6,7] Such films may also serve as neutralizer foils in space-based accelerators.[8,9] The stability of such films on spacecraft is thus of interest to a wide variety of researchers.

We can estimate the erosion rate of such films by atomic hydrogen in several ways. An approximate upper limit can be obtained by assuming that every hydrogen atom that arrives at the surface contributes to the formation of methane, i.e., an efficiency of 0.25 atoms removed/incident atom. According to Ref. 2, the atomic density of hydrogen atoms is about 8×10^{10} per cubic meter at altitudes from 150 km to greater than 1000 km. For a surface whose normal lies in the direction of the spacecraft's velocity, the maximum possible removal rate is then 1.5×10^{-5} Å/s, assuming a density of 2.00 grams per cubic centimeter for carbon films[10] and an orbital velocity of 8 km/s. An estimate can also be obtained from the results of King and Wise,[12] who studied the removal of carbon thin layers by atomic hydrogen at much higher atomic densities than the space environment. Using an effective temperature of 1000 K, their expression for removal rate yields 3.6×10^{-4} Å/s, much higher than the collision-limited rate. This estimate may be improved somewhat by assuming that the atomic removal efficiency is similar to that observed by Roth.[11] For low-energy deuterium ions incident on graphite, for which the yield is approximately 0.035 atoms/ion, we then estimate the net removal rate at 2.1×10^{-6} Å/s.

This rate may still be an overestimate; Rye[13] has pointed out that the reaction of atomic hydrogen with a carbon film is very slow until the film has been pretreated with hydrogen, and suggests some reaction probabilities lower than Roth's.

Peters *et al.* reported an experimental erosion rate due to oxygen of 0.15 Å/s for graphite at an altitude of 225 km and an orbital speed of 7.8 km/s. Only if this erosion rate due to oxygen were reduced by five orders of magnitude (by operating at greater altitude and/or by passivating against oxygen) would the erosion rate due to hydrogen be expected to be comparable, in which case the expected lifetime of a 1000 Å carbon coating would be several years.

We have benefitted from conversations with K. C. Hsieh and B. Strickland in this work, and are grateful to the referee who corrected a numerical error.

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Status Report on Metal-Coated Carbon Backings

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At the Thirteenth World Conference of the INTDS at Chalk River, Ontario, Canada a method was presented for producing very thin(~1$\mu g/cm^2$) targets of chlorine for use in high-resolution proton scattering experiments at a few MeV, at several microamperes of current. The method consisted in depositing a 0.5 - 1.0 $\mu g/cm^2$ layer of nickel on a 5 $\mu g/cm^2$ carbon backing, heating it for a few minutes under vacuum using an electron beam, and then depositing a layer of $BaCl_2$ on the resulting two-layered backing. The motivation for this approach was that the simplest possible targets of barium chloride deposited on carbon exhibited chemical decomposition under bombardment such that the amount of chlorine present in the beam spot decreased drastically; the decay strongly resembled a decaying exponential (and in fact could be fitted as one). It was found that a layer of nickel deposited on the carbon backing inhibited the target decay, but did not halt it; the decay observed was more linear in time, but continued until the final yield was 20-30% of the initial yield; an equilibrium point was eventually reached where the decay ceased. When the nickel-coated backing was heated ("baked") before deposition of the chloride salt however, it was possible to avoid decay entirely.

This technique, although successful, was problematic for low-energy (~1 MeV) elastic scattering in that the nickel peak began to overlap the chlorine peak in the charged particle spectrum at scattering angles near 90°. It was conjectured that heavier metals might be more suitable than nickel for this application. An attempt at this has been made, with encouraging but not entirely successful results.

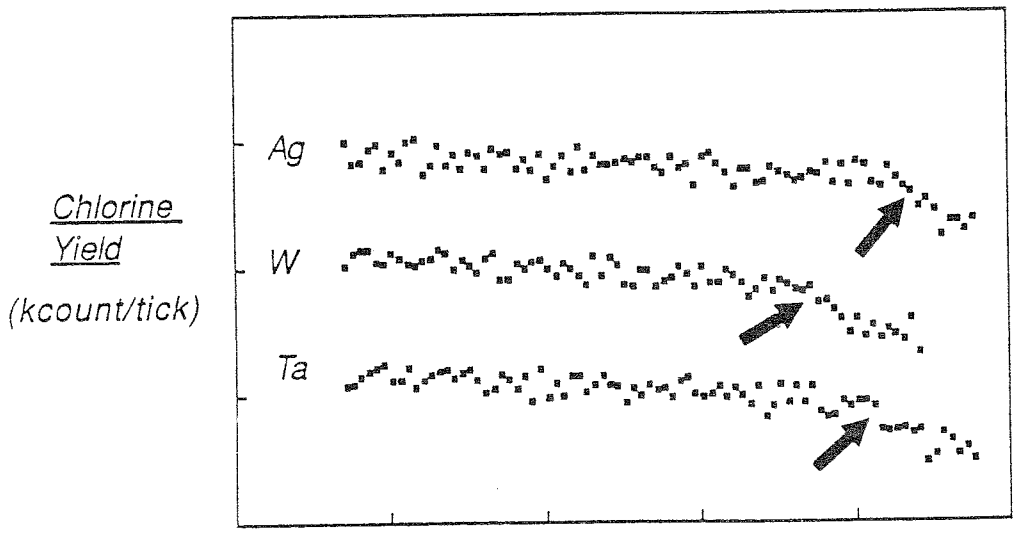
Two measurements were made using backings prepared exactly as before (ref. the last conference proceedings: NIM A257 vol.1, pp. 4-6), using instead of nickel the metals silver, tantalum and tungsten. A beam of 2 MeV protons was used to bombard the targets; a treatment which was found to give consistently good results with the original targets was to start with lower beam current and increase it to the desired current, and this was done here. Initially the beam current was 0.5 microamperes, being increased after about ten data points to 1.0 microamperes and similarly increasing to 1.5, 2.0, and 3.0 microamperes. Each data point represents 100 microcoulombs of charge passed through the target. With the original nickel-coated carbon foils this procedure consistently produced non-decaying targets. These three kinds of targets exhibited

the behaviour plotted below.

In the figure below the data are plotted according to the same scales with each plot displaced so as to facilitate comparisons. (Each vertical scale mark represents 1000 counts, and the initial number of counts was about 2000 for each target) It is seen that decay exists in each case but that it is a slow kind of linear decay, up until the point where 3.0 microamperes of incident beam current is used. This point is indicated by the arrows for each target. From that point on the decay is more pronounced for each target. The slope of the decay prior to that point appears roughly the same for each, and the point scatter appears to be about the same for each sample.

In conclusion, the effect of the metal coating of the carbon foil was to inhibit the decay but not prevent it for $BaCl_2$ targets. Based on the experience with nickel, this could be an indication that non-decaying targets can be made by further variations on the present method, such as heating for a longer period of time or to a higher temperature. However, that remains unproven; thus far it is evident that using the present technique is effective only with nickel. Nonetheless the other metals hold some promise and further development work may produce satisfactory results if the experimental requirements were to warrant the effort.

Cl Yield vs. Charge
for Beam Currents of 0.5-3.0 Microamperes



This work was supported by the US Department of Energy, Office of High Energy and Nuclear Physics, under Contract No. DE-AC05-76ER01067.

Announcement

Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

We are happy to announce that John Greene has accepted the position of producing thin films for the Physics Division at Argonne National Laboratory. Feel free to give him a call any time and welcome him into the fraternal order of target markers.

George E. Thomas
Physics Division

SAMPLES AND TARGETS FOR NUCLEAR MEASUREMENTS DELIVERED BY CBNM DURING 1987

J. Pauwels, J. Van Audenhove, C. Ingelbrecht and R. Eykens
Joint Research Centre, Central Bureau for Nuclear Measurements,
Geel, Belgium

In the period between 15 October 1986 and 15 October 1987, 456 samples and targets as well as dosimetry reference materials covering 104 orders have been supplied to 28 customers, especially nuclear research centres and universities.

1. SAMPLES AND TARGETS ON REQUEST

These consist of :

a) thin deposits (Table 1) prepared by vacuum deposition (VD), cathodic sputtering (CS), electrolysis (EL), spraypainting (SP), solution (SO) - or suspension spraying (SU), and are mostly α - active materials characterized by low-geometry α-counting and/or mass spectrometry, or non-active materials characterized by weighing, spectrophotometry or using oscillating quartz devices;

b) thin plastic foils supplied directly to interested customers (191 foils covering 11 orders) or prepared for internal use at CBNM-SP as substrates for targets. These are prepared either by centrifuging a solution of the polymer (e.g. Formvar) or by in-situ synthesis on glass plates (Polyimide). The thicknesses of these foils are generally in the range 20 to 50 $\mu g \cdot cm^{-2}$, and are guaranteed at 0.5 to 1.0 $\mu g \cdot cm^{-2}$ on the basis of a spectrophotometric thickness determination;

Table 1 . Supply of thin deposits

Preparations	Number of Orders	Number of Samples	Preparation Methods
Al on plexiglass	1	1	VD
Au on Cs_2SiF_6	1	2	CS
^{10}B on silicon	1	2	VD
Ca on stainless steel	1	4	VD
^{6}Li on Al or Si	3	5	VD
Ni on polyimide	1	6	CS,VD
^{237}Np on PI or stainless steel	4	14	VD
^{239}Pu on PI, st. steel or Ti	4	9	VD,SP
^{230}Th on molybdenum	3	3	SU
^{232}Th on polyimide	1	1	VD
^{233}U on titanium	2	17	SP
^{235}U on Al, mylar, Ni, polyimide, Si, St. steel, or Ti	10	41	VD,SP,EL SO, SU
^{238}U on polyimide	1	1	SU

Table 2 . Supply of Bulk Samples

Material	Number of Orders	Number of Samples	Preparation Methods
Bismuth	1	14	M - MA
Copper	2	2	WD
Iron	1	1	WD
Lithium in Al	4	6	R - CAN
Sodium in Al	1	4	M - CAN
Niobium	2	2	WD
Nickel	1	1	WD
^{58}Ni	1	1	M - R
^{60}Ni	1	1	M - R
Lead	1	1	M - R
Sulphur	2	16	PR
^{230}Th	1	1	CAN
^{232}Th	1	1	CAN
^{235}U	1	9	MA
Tungsten	1	4	MA

Table 3 . Supply of Quantitative Alloys

Alloy	Number of Orders	Number of Samples	Preparation Methods
Ag - Mn	2	2	M - SW
Al - Au	1	1	LM - WD
Al - Co	1	1	LM - R - WD
Al - Eu	1	1	LM - R - WD
Al - Lu	1	1	LM - R - WD
Al - Mn	1	1	LM - R - WD
Al - Th	1	1	LM - R - WD
Al - U	1	1	LM - R - WD
Cd - Cu	1	1	M - R -SW
Cd - Sb	2	6	M - R - SW
Cu - Ag	4	4	M - R - WD
Cu - Fe	1	1	M
Cu - Mn	2	2	M - R
Pb - Ag	1	1	M - R - SW
Pb - In	5	5	M - R - SW
Sn - Zn	1	5	M - R - SW
^{235}U - ^{239}Pu	1	30	LM - MA

c) powder or metal samples (table 2) transformed by pressing (PR), high frequency levitation (LM) or classical melting (M) and possibly canned (CAN). Final shaping of these samples is generally carried out using techniques such as machining (MA), wire drawing (WD), swaging (SW) or rolling (R).

Powder samples of three nickel isotopes : ^{58}Ni, ^{60}Ni and ^{61}Ni, are at present on loan from ORNL. CBNM-Linac requested the transformation of these samples into solid discs for transmission experiments, with the requirement that all the available material be used and losses minimised because of the high value (approx. 500 000 $) of the isotopes. Two of them (^{58}Ni and ^{60}Ni) were delivered to the customer, ^{61}Ni being in process.

Different melting techniques were used in each case because of the difference in sample size. The ^{60}Ni was induction melted in a zirconia crucible, the ^{58}Ni was melted by a semi-levitation (crucible-less) technique, whereas the ^{61}Ni will be processed by cold-crucible levitation. The ^{58}Ni and ^{60}Ni samples were then finished by pressing and rolling to the required diameter.

d) quantitative alloys (table 3) prepared using the above techniques and guaranteed for their content, homogeneity, or, in the case of temperature monitors, for their melting point.

Over the past 25 years CBNM has carried out much pioneering and development work on levitation melting and produced hundreds of different alloys for neutron dosimetry, chemical analysis and solid spiking. The year 1987 saw a major widening of capacity in this area with the purchase of a cold-crucible levitation melting and casting system incorporating a 100 KW variable frequency generator. This equipment can be used to levitate and melt, in safety, up to 400 g of metals such as vanadium and zirconium, which because of their high densities and melting points are difficult to melt using conventional levitation techniques. The cold-crucible melting equipment therefore facilitates the production of alloys that are likely to be required, e.g. for neutron dosimetry in the future.

It is planned to commission the new equipment before the end of 1987.

2. REFERENCE MATERIALS FOR REACTOR NEUTRON DOSIMETRY

Due to the importance of an assured supply of reference materials for use in neutron dosimetry, CBNM collaborated with the Monitor Materials subgroup of EWGRD (European Working Group on Reactor Dosimetry) to establish a list of requirements. CBNM is organizing the procurement and characterization of these materials useful for reactor surveillance and neutron metrology. Despite the fact that interlaboratory analytical characterization exercises are still going on (Al, Cu, Fe, Nb, Np), seven of these materials have already been made available for sale (table 4), on explicit request of the Monitor Materials Subgroup of EWGRD.

During 1987, the preparation of NRM-502 : neptunium oxide (AERE Harwell) and the transformation of NRM-525 and 526 : niobium into 0.5 mm diameter wire, and into 20 µm and 0.1 mm thick foil (CBNM Geel), was finished, and the study of the transformation of rhodium powder into a 50 µm thin foil was started : therefore, a 5 g powder sample was pressed, melted by semi-levitation and hot rolled into foil. Subsequent analysis showed that only minimal contamination was introduced by this processing route.

Table 4. Reactor neutron dosimetry Reference Materials available for sale

Material	Form	Diameter or Thickness [mm]	Status
^{238}U oxide (NRM-501)	Spheres	0.5 1.0	Submission to Certification Committee : 26 November 1987
^{237}Np oxide (NRM-502)	Spheres	0.5 0.8	Certification analyses in preparation
Nickel (NRM-521)	Foil Wire	0.1 0.5	Submission to Certification Committee : 26 November 1987
Copper (NRM-522)	Foil Wire	0.1 1.0 0.5 1.0	Certification analyses in progress
Aluminium (NRM-523)	Foil Wire	1.0 0.1 1.0	Complemental analyses still going on
Iron (NRM-524)	Foil Wire	0.1 0.5	Certification analyses in progress
Niobium (NRM-522) (NRM-526)	Foil Wire	0.1 0.02 0.5	Transformation of the 2 varieties completed; certification analyses going on

However, to avoid oxidation problems, an inert atmosphere rolling facility is being recommissioned for the production of the candidate reference material.

Finally, the certificates and reports of NRM-501 (uranium-238 oxide) and NRM-521 (nickel) will be submitted to the certification committee for official approval on 26 November 1987.

Source : CBNM Programme Progress Report 1987