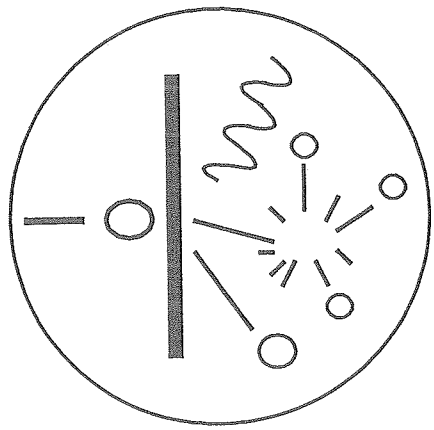
# INTERNATIONAL NUCLEAR

# TARGET DEVELOPMENT SOCIETY

# NEWSLETTER



July 1997, Vol. 24, No. 1

**Vol. 24, No. 1 - July 1997**

International Nuclear Target Development Society
c/o Mrs Joanne M. Heagney
P.O. Box 123
Deer Harbor, WA 98243
USA
Tel: +1-360-376-4007
Fax: +1-360-376-5356

Editor: Chris Ingelbrecht
Institute for Reference Materials and Measurements,
Joint Research Centre,
European Commission
Retieseweg
B-2400 Geel, Belgium

Tel: +32-14-571-600
Telefax: +32-14-590-406
E-mail: Ingelbrecht@irmm.jrc.be

# CONTENTS

# EDITOR'S NOTE

Dear Colleagues,

A somewhat quiet edition of the Newsletter. Members are kindly requested to check their addresses in the list at the end of the Newsletter; there are certainly a lot of e-mail addresses that could be added.

Chris Ingelbrecht
Editor

# Report on the Seventh International Workshop on Targetry and Target Chemistry

This workshop, organised by Frank Helus took place at the German Cancer Research Institute, 9-11 June, with about 150 participants, and was the latest in a series of biennial gatherings for target users and makers for isotopes for radiopharmaceuticals. The most important subject is the production of short half-life position emitters for PET imaging (various compounds of $^{11}C$, $^{13}N$, $^{15}O$, $^{18}F$) by cyclotron irradiation, chemical separation and injection into the patient, all at the medical facility.

There were a number of topics common to most PET cyclotron operators and the presentations and discussion centred on these: target containment, target cooling at high beam intensities, chemical separation and the collection of the isotopes produced. There was also some work on other short and medium-lived isotopes (Cu, Zn, Ga, At, Ce, Kr, ...) for PET or as tumor specific $\alpha$-emitters.

The targets themselves may be either liquid (labelled water) gas or solid and can be either internal or internal, i.e. separated by thin Ti, Al or HAVAR windows from the cyclotron. Irradiation is with positive or negative light particles (p, d, He).

The conference was conducted in genuine workshop style with short informal presentations and extended discussion, which worked well because of the common nature of the problems for the limited number of isotopes of interest. A short presentation on INTDS history and activities was made by Bill Lozowski.

C. Ingelbrecht

8 July 1997

# A Short Note on the Preparation of Uranium Carbide Pellets Used for Fission Production Targets

*John P. Greene, Patrick Decrock, Jerry A. Nolen and George E. Thomas*
*Argonne National Laboratory, 9700 S. Cass Avenue, Argonne, IL 60439, USA*
*Willard Talbert*
*Amparo Corporation, P.O. Box 2687 Santa Fe, NM 87504, USA*

## Introduction

For the production and acceleration of unstable heavy-ion beams, a suitable source of fission fragments of the ISOL type is being developed at Argonne National Laboratory [1]. Initial plans call for uranium carbide targets similar to those presently employed at CERN. The preparation of this target will be described. Preliminary analysis of the physical and thermal properties of the uranium carbide pellets will be presented.

## Experimental Method

The preparation of the uranium carbide pellets proceeds from the reduction of the oxide with an excess of graphite as previously described [2]. The equation is given as follows:

$$UO_2 + 6C \rightarrow UC_2 + 2CO + 2C.$$

Depleted uranium oxide and powdered graphite were obtained from Cerac, Inc. and mixed in a proportion of 79 % to 21 %. For the thermal analysis, two sample sizes were desired. For the thermal conductivity measurement, a 9.7 mm diameter pellet was used and for specific heat determination, a sample size of 4.5 mm diameter was prepared. In both cases the pellet thickness was 1.5 mm. The powdered mixtures were pelletized using a pellet press from Parr Inc., dimensionally measured, and carefully weighed before heating.

The reduction to the carbide was carried out in a resistively heated source within a F.J. Cooke, Inc. vacuum evaporator [3]. Upon heating under vacuum there is at first, an initial pressure rise due to the evolution of water vapor and/or trapped gases from within the pellet. Further heating produces a second pressure excursion near 1200 °C, presumably the reduction temperature. Reweighing of the sample after venting with argon shows a weight loss of 16 %, approximately what would be expected from the above equation.

## Physical and Thermal Properties of $UC_2$ Pellets

Several $UC_2$ samples were obtained in this manner with their physical properties given in Table 1. The higher densities obtained for the smaller samples may be due in part to the calculated amounts of the mixtures needed to approximate the densities obtained with the larger samples BEFORE reduction. There is possibly too much excess carbon remaining in these smaller samples. The samples were then sent to Thermophysical Properties Research Laboratories (TPRL) for thermal analysis.

The thermophysical properties of two of the samples were determined [4]. Thermal diffusivity ($\alpha$) was measured by the laser flash diffusivity method using an apparatus developed at TPRL. In the flash method, the front face of the pellet sample is subjected to a short laser pulse and the resulting rise in temperature of the rear face of the pellet is recorded. Specific heat ($C_p$) was determined using a Perkin-Elmer Model DSC-2 Differential Scanning Calorimeter with sapphire as a reference material. The thermal conductivity ($\lambda$) is then calculated using the relation:

$= \alpha\, C_p\, d,$ where d is the bulk density.

Tables 2, 3 and 4 give the results of these measurements (from Ref. 4).

**Further Research**

With these preliminary analyses done, a complete ISOL type target/ionizer assembly [5] is under construction at the Argonne Physics Division Dynamitron Accelerator Facility. This target will employ a stack of much larger pellets, approximately 18 mm diameter by 3 mm thick. Various mixture recipes and target configurations will be explored in order to maximize fission release yields. Further research is being carried out.

**Acknowledgments**

This work is supported by the U.S. Department of Energy, Nuclear Physics Division, under contract W-31-109-ENG-38.

**References**

[1] *"CONCEPT FOR AN ADVANCED EXOTIC BEAM FACILITY BASED ON ATLAS,"* (A Working Paper), Physics Division, Argonne National Laboratory, February 1995

[2] A.H.M. Evensen, et. al., Nucl. Instr. and Meth. **B 126** (1997) 160-165

[3] John P. Greene, Irshad Ahmad and George E. Thomas, Nucl. Instr. and Meth. **A334** (1993) 101-110

[4] **TPRL 1825** *"Thermophysical Properties of Uranium Carbide Plus Carbon Samples,"* R.E. Taylor, H. Groot and J. Ferrier, March 1997

[5] *"Ion source test stand for radioactive fission fragments,"* J.A. Nolen, P. Decrock, M. Portillo, T.P. Mullen, A.A. Geraci, T.A. Barlow, J.P. Greene, I.Gomes, C.H. Batson and S.E. Saremba, **ABSTRACT for ICIS97**

TABLE 1 - Physical Properties of the $UC_2$ Pellet Samples

| **Sample #** | **Dia.** | **Thick** | **Final Wt.** | **Density** | **Wt. Loss** |
|---|---|---|---|---|---|
| (mm) | (mm) | (g) | (g/cc) | | |
| 4 | 9.70 | 1.41 | 0.27365 | 2.63 | 16.65% |
| 5 | 9.67 | 1.41 | 0.26785 | 2.59 | 15.74% |
| 6 | 9.75 | 1.38 | 0.2676 | 2.60 | 15.68% |
| 7 | 4.51 | 1.33 | 0.0634 | 2.98 | 15.47% |
| 8 | 4.53 | 1.27 | 0.0608 | 2.97 | 16.54% |
| 9 | 4.50 | 1.35 | 0.0636 | 2.96 | 15.54% |
| 10 | 9.75 | 1.38 | 0.2657 | 2.58 | 16.2% |
| 11 | 9.81 | 1.39 | 0.2669 | 2.54 | 17.6% |
| 12 | 9.76 | 1.43 | 0.2724 | 2.55 | 16.3% |
| 13 | 9.75 | 1.35 | 0.2682 | 2.66 | 17.2% |

TABLE 2 - Thermal Diffusivity Results

| **Sample #** | **Temperature** | **Diffusivity** |
|---|---|---|
| (C) | ($cm^2$ $sec^{-1}$) | |
| 10 | 23.0 | 0.00500 |
| 100.0 | 0.00390 | |
| 200.0 | 0.00307 | |
| 300.0 | 0.00256 | |
| 400.0 | 0.00183 | |
| 500.0 | 0.00050 | |

TABLE 3 - Specific Heat Results

| **Sample #** (C) | **Temperature** (W-s/gm-K) | **Specific Heat** |
|---|---|---|
| 7 | 23.0 | 0.3210 |
| 50.0 | 0.3480 | |
| 75.0 | 0.3720 | |
| 100.0 | 0.3940 | |
| 125.0 | 0.4130 | |
| 150.0 | 0.4270 | |
| 175.0 | 0.4380 | |
| 200.0 | 0.4490 | |
| 225.0 | 0.4580 | |
| 250.0 | 0.4660 | |
| 275.0 | 0.4730 | |
| 300.0 | 0.4780 | |

TABLE 4 - Thermal Conductivity Calculations

| **Sample #** (C) | **Temperature** ($W\text{-}cm^{-1}\ K^{-1}$) | **Thermal Conductivity** |
|---|---|---|
| 10 | 23.0 | 0.00414 |
| 100.0 | 0.00396 | |
| 200.0 | 0.00355 | |
| 300.0 | 0.00316 | |