INTDS NEWSLETTER

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The INTDS Newsletter is an informal source of information for and from the membership.
The INTDS assumes no responsibility for the statements and options advanced by the contributions.

Cover picture: A beta= 0.101 Split loop Superconducting Resonator
This photo shows one of the 42 resonant cavities which comprise the University at Stony Brook Nuclear Structure Laboratory superconduction Linac. The Stony Brook accelerator, consisting of a negative ionsource and 9 mV Van de Graaff injection the Linac, can accelerate a wide variety of heavy ions to 10-15% of the speed of light. NLS researchers study nuclear structure, nuclear reactions, accelerator physics and fundamental interactions.
This cavity has been electroplated with a 2 micron layer of lead-tin alloy atop an OFHC copper substrate. Operating at 150 MHz, each cavity can create accelerating fields of 3-4 MV/m when cooled to 4.5 K.
For more information on the USB NSL try: http://nuclear.physics.sunysb.edu

Editor's Note

The INTDS web site is now on line. Please have a look at http://ww.intds.org and make comments and suggestions if you can. You may add a link to your own target preparation site if you have one.

Please also check the address information at the back of this newsletter and send corrections to me. I am sure that there are many email addresses missing.

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INTDS Award Presentation to Helmut Folger, Oak Ridge, Tennessee, 7 October 1998

This evening, the INTDS will present an Award of Recognition to Helmut Folger for Contributions to our Society, and science, during his professional career.

At the University of Mainz, Helmut's undergraduate interest was chemistry. His graduate work at the Institute for Nuclear Chemistry there was completed under Giinter Hermann who, in 1973, persuaded Helmut to join him at GSI, then a very new facility.

Helmut's first INTDS meeting was in 1977 at the Laurence Berkley Laboratory (LBL). He presented a paper and we learned that he and Josef Klemm had made uranium sandwiches. Not for social events, these were multi-layered targets designed to protect vacuum-deposited uranium layers from oxidation.

The following year, in Garching, Helmut reported that he, Klemm and U. Richter had used explosives to bond uranium and copper layers. Now *this* was quite enough to wake even a room of people who thought themselves adventurous in the lab. The report was, of course, a meticulous scientific work in which he explained why one might need to consider blasting two layers together for thermal conductance par excellence.

That year, 1979, Helmut became the head of the GSI Target Lab, which in turn became a world-class facility with an impressive work load. Helmut's responsibility was to develop technologies and equipment, and to supervise three other target makers. The unique target wheels he developed were essential to the discovery of the heaviest elements found to date. Thus, he is listed as an author on those historic papers.

When asked if he was an experimentalist or a target maker, Helmut would reply that he had a foot in each camp. In fact, his feet were in other camps as well. He collaborated with the Ion Source Group at GSI, and with ORNL, on the production of stable isotopes for the accelerator beams necessary to conduct the super-heavy-element experiments. Twice, he was elected to the Board of the ORNL Electro-Magnet Separators Users Group.

Helmut has made 25 contributions to INTDS publications, all of which were first rate. He served two elected terms of service on the INTDS Board, and then refused to consider a third term because he wanted to make room for new blood. During his twenty-one INTDS years, he was fully engaged on every issue and was an excellent influence. In Chalk River, he said "No" when President Harold Adair asked him to consider taking the reins of the presidency. Helmut feared he would not find the time he felt necessary to do the job well.

At GSI in 1988, Helmut hosted the 14th World Conference of the INTDS - conducted as a joint conference with the IAEA International Nuclear Data Committee. He had recognized the value of bringing together target makers with this United Nations advisory group concerned with the influence of target and sample properties on nuclear data measurements. Helmut edited those proceedings, our largest, and shouldered the burden of convincing everyone who reviewed the papers the value of using hyphens correctly.

At the end of 1996, Helmut retired from GSI, yet he is collaborating internationally on several scientific projects. Thank you, Helmut, for so many years of exceptional service.

Surface Perturbation Targets for the Study of Rayleigh-Taylor Instability in Inertial-Confinement Fusion Experiments

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Abstract A preparation process for surface perturbation targets on brominated polystyrene foils is described. Laser interference produces a perturbation figure on a photoresist plate, onto which nickel is electroplated. This nickel layer is used to produce a second nickel mould, from which brominated polystyrene foils are produced by spin-coating. The precision of the transfer process was investigated by SEM and by an α-step apparatus. The bromine content of the polystyrene was determined and surface roughness of the perturbation targets was measured.

1. Introduction

Rayleigh-Taylor instability in inertial-confinement fusion is a key problem, already studied in a number of experiments (1-4), and the surface perturbation target is an important part of these experiments. Dittrich and co-workers at LLNL had worked on Rayleigh-Taylor instability caused by surface roughness of the target by preparing sine perturbation figures on organic foil to simulate the surface roughness of the ICF pill target. LLNL simulated instability in three dimensions (5), but there was no complete information on the preparation process for the surface perturbation target.

In this paper we introduce an effective method for preparing surface perturbation targets by combining modern micro-process technology and modern measurement methods.

2. Preparation process

A photoresist film was put onto a glass plate by spin coating and laser interference (6,7) was used to form a perturbation figure, with two interfering beams to producing a sine modulation. An Ag film was deposited onto the photoresist plate by evaporation. A Ni layer was then added by electroplating onto the Ag film, with the Ag as the negative electrode. This Ni layer was then removed from the glass plate and passivated. This “primary mould” was then electroplated with Ni again to produce a “secondary mould”, carrying the sine-modulated surface profile, and the two moulds were separated.

The electroplating solution was $Ni(NH_2SO_3)_2$, with Ni of purity 99.9% as anode. The electroplating conditions were controlled to achieve a nickel deposit of good smoothness and high density. The pH was 3.8-4.0, the temperature 40-42°C, and the current density several to tens of mA/cm^2. At the same time the cleanliness of the photoresist and Ni-plate was a key factor in achieving a good figure transfer.

Targets for the study of Rayleigh-Taylor instability need material with a low Z and polystyrene was selected in this case. Bromine, added as a dopant, increases the ablation pressure of the film and decreases the pre-heating. Brominated polystyrene

in a chloroform solution was spin-coated onto the secondary nickel mould, or was cast onto the mould and the chloroform was allowed to evaporate. The polystyrene film, carrying the sine-modulated surface profile was then removed from the mould by scraping.
The surface of the film was studied by SEM (Leica-Cambridge S 360) and an α-step apparatus (Type 500, Tencor Corporation) was used to measure the surface roughness. The film preparation process is shown in Fig. 1.

3 Results and Discussion

Precise figure transfer is a key factor in preparing surface perturbation targets. An SEM micrograph of the sine-modulated perturbation figure on the secondary mould plate is shown in Fig.2. The final step was the transfer of the figure to the polystyrene foil. It was found that cast foils were not of good quality because of uneven flow over the surface of the mould, resulting in irregular thickness, compared to the spin-coated foils.
The surface roughness is a crucial parameter in the use of the targets. The results of the α-step measurements are shown in Fig. 3. for a measurement distance of about 5 μm. These measurements showed that the surface roughnesses of the Ni mould plate, foils prepared by spin-coating and by casting were 15nm, 14.2nm and 9,8nm respectively.
The brominated polystyrene was made in our laboratory. The molecular weight, measured using a Waters GPC-150C Gel Chromatograph, was found to be 7000-10000, and the distribution of molecular weight d<2. The bromine content, measured by Dionex 2020I Ion Chromatograph was 12.8 mole %.

4. Conclusions

A nickel mould plate was made using laser interference, combined with nickel electroplating figure transfer. Brominated polystyrene foils with sine-modulated perturbation figures were prepared by spin-coating and casting. The study of the figure transfer process showed that the perturbation figure had not changed during the transfer process. Using this technique modulated mould plates with wavelengths 20-100μm and amplitude 0.2-3.5μm were obtained. This figure transfer process satisfies the requirements of the ICF experiments.

Acknowledgements

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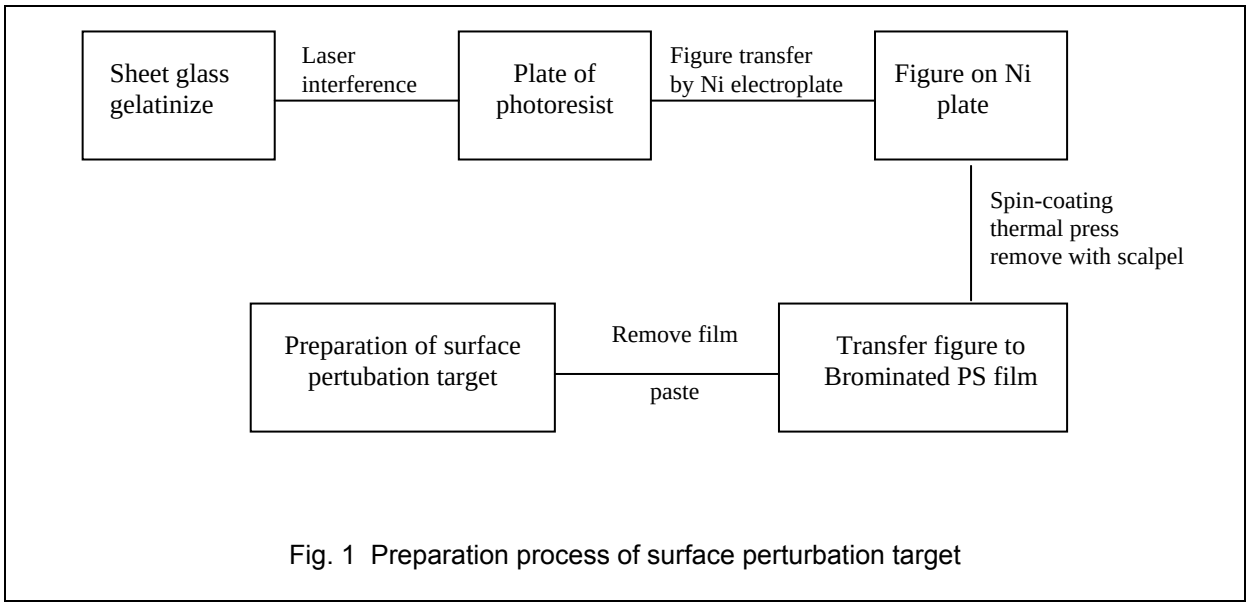

Fig. 1 Preparation process of surface perturbation target

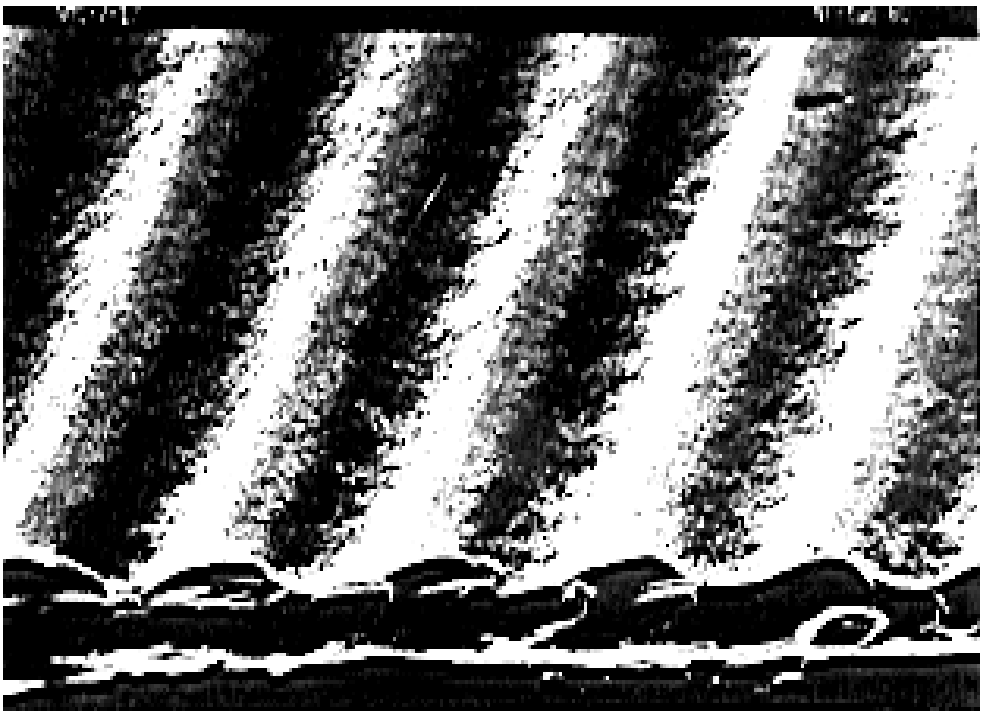

Fig.2. SEM micrograph of secondary mould plate

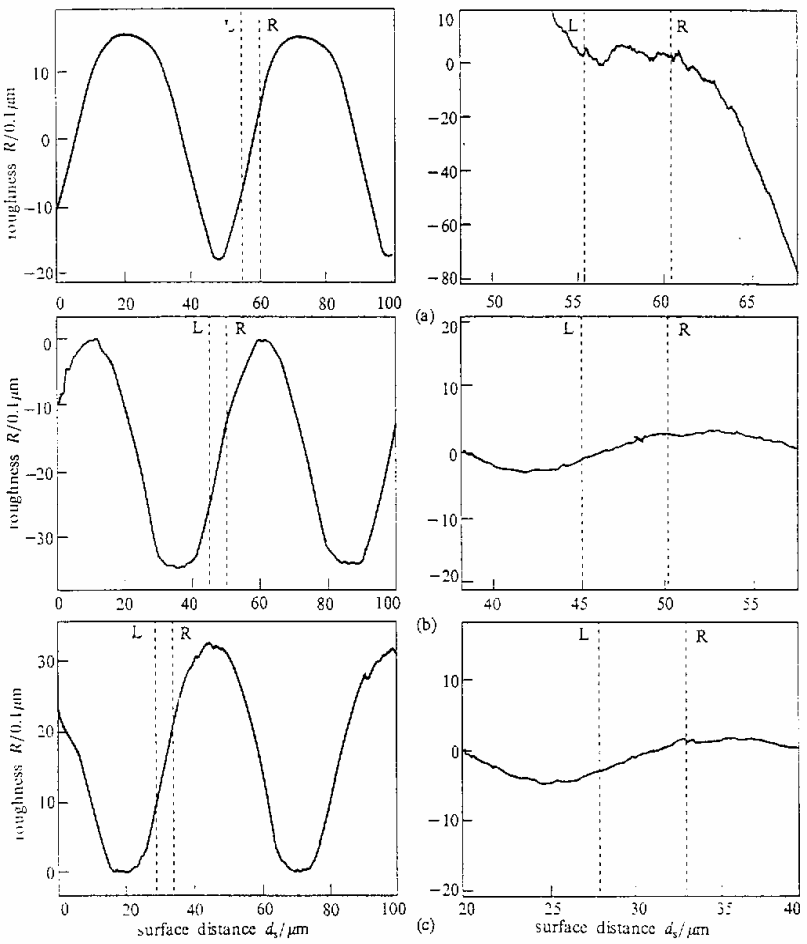

Fig. 3. Surface roughness on surface perturbation target of Brominated polystyrene

(a) surface roughness on Ni plate
(b) surface roughness on foil prepared by spin-coating
(c) surface roughness on foil prepared by casting process

Preparation of a 5.5-mg/cm² sodium target by rolling

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Elemental sodium was rolled to dimensions of 25 mm x 25 mm x 57-µm thick for an experiment with 200-MeV polarized protons in the IUCF K600 magnetic spectrograph. At IUCF, roll-reduction of Na was previously done with a hydraulically driven rolling mill in a glove box filled with dry Ar. Production of a Na target of < 10 mg/cm² by this process was predicted to be slow and arduous. Although the target had to be nearly oxygen-free, with simple protective measures and a rolling mill in room air, a thick piece of Na was rolled quickly and successfully to 5.5 ± 0.1 mg/cm². A listing of the process equipment and procedures follows.

Equipment

1) A glass glove box (70-cm long x 30-cm high x 30-cm deep), positioned near the rolling mill, fitted with: shoulder-length, 5 0-µm thick, polyethylene gloves; a top port (100-mm diameter, normally covered with a glass plate), and a gas-tube fitting positioned low on the back side of the box;
2) A rolling mill with 203-mm wide x 127-mm diameter rolls.
3) A glove box filled with Ar gas maintained at O_2 and H_2O levels of $\leq$ 3 ppm and fitted with a docking port for inert gas or vacuum transfer of targets.

Procedure

1) After the glass glove box was purged with dry Ar, the flow rate of Ar through the box was sustained at 10 ml/minute.
2) Within the Ar-filled glass glove box, a Na block was withdrawn from storage beneath the surface of high-grade mineral oil. A piece of Na approximately 3-mm thick x 10 mm x 10 mm was trimmed from it (using a single-edge razor blade), then re-coated with the mineral oil.
3) A transparent Mylar rolling pack, 125-to 250-µm thick x 150 mm x 300 mm (folded to 150 mm on a side), was dried for 15 minutes in an oven (air atmosphere) at 363 K.
4) Inside the glove box, the Mylar pack was allowed to cool before the Na was placed in contact with it. During roll thinning, done outside the glove box, the rate at which the Na darkened was found adequately slow.
5) For the first 95 % (approximate) of the Na-thinning process, the rolls of the rolling mill were not driven. Rather, the Mylar pack was pushed and pulled by hand through the rolls. To avoid sticking the Na to the pack, the force necessary for these actions was limited to about 200 g, by careful control of the distance between the rolls.
6) The pack was turned 90° after each push-pull sequence.
7) When the push-pull force decreased to about 50 g, the distance between the rolls was decreased about 10 µm.
8) Each time the area of the Na had grown by 20-30 %, the pack was returned to the glove box to re-coat the Na with mineral oil and/or reposition it in the pack if any sticking had occurred.
9) When the diameter of the Na foil was about 38 mm, it was trimmed to a square about 19 mm on a side. Final rolling was done with the motor drive engaged and multiple passes were used for each roll-separation reduction of 5-10 µm.
10) When the thickness was 5.5 mg/cm² , as determined with a micrometer with 2.5 µm sensitivity, the Na foil and pack were transferred to the last glove box listed in the equipment section above and the residual oil was blotted with Kimwipes.

The preparation of ^{123}Te targets by electrodeposition

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Introduction

Targets of ^{123}Te were required as part of a systematic study of (n,α) reactions and also for investigation into the ^{123}Te(n,α)^{120}Sn "branching" reaction during stellar nucleosynthesis of the elements. A rectangular layer 50x60 mm² was requested, to fit, at an angle, into a square neutron beam guide at the ILL reactor in Grenoble.

Target preparation

Target substrates were 20 µm aluminium foils mounted on rectangular brass frames of external dimensions 97 x 82 mm². A large sheet of foil was tensioned in as special jig (Fig. 1) and lightly abraded on one side using 2500 grit SiC paper. The brass frames were then glued onto the foil using polymethylmethacrylate-based glue.
After curing in vacuum the target frames were heated in air to 180°C for 10 min. to drive of some of the remaining volatile components of the glue.
Only 10 mg of ^{123}Te oxide starting material was available (89.39 % enriched) and the relatively high yielding method of "molecular plating" or electrodeposition from organic medium [1,2] was selected. The deposition cell [3] was made from PVC with a stainless steel substrate holder and platinum grid anode.
A Te mother solution of 6.5 g.l^{-1} was made by dissolving the Te oxide starting material in 14.4 M HNO_3 at 110°C. A 500 µl aliquot of this nitrate solution was then added to 60 ml ethanol in the cell and deposition was carried out at 5 mA.cm^{-2} for 150 mins. Optimum deposition conditions were determined by trials using natural Te. Target calcination was carried out in oven at 300 °C using a special water-cooled jig (Fig. 3) clamped onto the target frame to cool the glue used for the foil mounting.

Target characterization

Three ^{123}Te targets were produced from the isotopic material available. Deposit masses were recorded and one of these samples was destructively analysed by neutron activation analysis (NAA) using activation of ^{130}Te and decay of ^{131}I:

$$^{130}\text{Te}\ (n,\gamma)\ ^{131}\text{Te} \xrightarrow{\beta^-,\ T_{1/2}\ =\ 25\ \text{mins}} {}^{131}\text{I} \xrightarrow[\gamma_{364\ \text{keV}}]{\beta^-,\ T_{1/2}\ =\ 8\ \text{d}} {}^{131}\text{Xe}$$

The NAA and weighing results allowed a calculation of the Te mass fraction on this deposit and this value was then used to estimate the mass of Te on the other two deposits (120 µg/cm² and 190 µg/cm²), which were reserved for the physics experiment. The evolution of mass Te areal density (by NAA) and total areal density (by weighing) was also studied for deposits of natural Te, and these data are given in Fig. 3.

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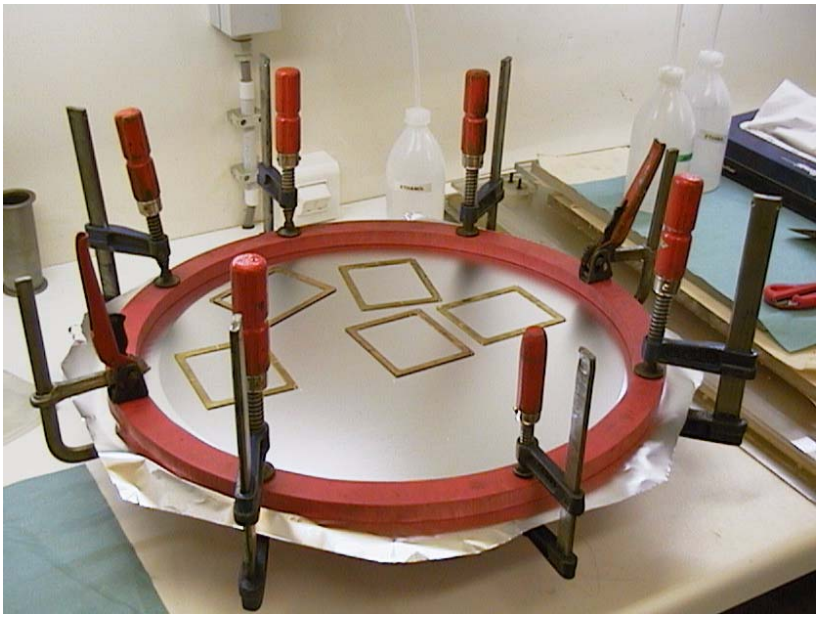

Fig 1. Foil tensioning jig with target frames glued in position

Fig. 2. The cooling jig used to protect the glue used for the target mounting

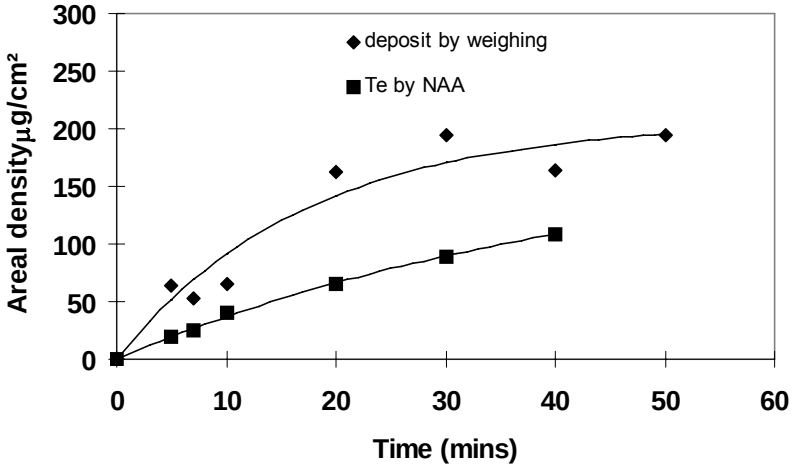

Fig. 3. Increase of target areal density (by weighing) and Te (by NAA) after deposition times up to 50 mins. Current density 5mA/cm^2