



**NPL Polarized Source Group
Technical Note # 90-8**

**The Fabrication of Tantalum Cups for the
Illinois/CEBAF Polarized Electron Source**

B. M. Dunham, L. S. Cardman, and C. K. Sinclair

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university of illinois at urbana-champaign

nuclear physics laboratory

department of physics



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NPL has paid for the design and construction of a specialized set of dies for use in the fabrication of the tantalum cups needed for the Illinois/CEBAF polarized source (NPL drawing number 2709-8 for the cups for 18 mm photocathodes (our standard size for bulk GaAs samples), and 2709-89 for the cups for 12.5 mm photocathodes (our standard size for the chalcopyrite samples). There are two dies. The first is a two-stage "blank and draw" die that will cut out an appropriate diameter circle of tantalum and draw it into the shape of the cup. The second is a two-station die for punching the holes in the center of the cup. This die can produce holes in the cups having either a .590" diameter (for 18 mm photocathodes) or .372" diameter (for 12.5 mm photocathodes) depending on which station is used. Drawings of the two dies are attached to this memorandum; full-sized versions of the drawings are stored in the NPL drawing files as drawing numbers 2778-1 and -2. The dies were purchased from Action Tool and Die Co., 3374 Precision Drive, Rockford, IL 61109, phone (815)-874-5775. The Blank and Draw die was ordered on U of I PO # JU-87262-PR (requisition number 7199), dated June 8, 1989, and the two-station pierce die was ordered on U of I PO # JU-89890-PR (requisition number 7221) dated July 5, 1989. The dies cost \$3,960 and \$3,250, respectively. Similar costs would apply for variations on the present design with the exception of different hole diameters, which could be added to the two-station pierce die by changing a few parts.

In order to fabricate a batch of cups, it is necessary for someone to go to Action Tool and Die for about a day to supervise the cleaning of the material prior to manufacture, to supervise the cleanliness of the manufacturing process, and serve as "quality control" officer for the finished product. Mr. Troy Gay of Action Tool and Die should be contacted prior to the visit to arrange a date and to define the cost of the manufacturing process. A purchase order to cover the estimated costs should be sent to Action Tool and Die prior to the date of the manufacturing. The first time this was done (in August, 1989) a total of about 150 cups were manufactured in a day for a cost of \$500 (plus materials costs). In the following we outline the steps that must be followed to obtain cups of appropriate quality.

Material:

The cups are fabricated from .005" thick Tantalum foil. The tantalum should have 8 μ inch surface finish (or better) with no roll lines or surface defects. It should be shipped in a flat, hard container to prevent bending and damage from shipping. In the past we have used 12" \times 12" \times 0.005" thick sheet ordered from Electronic Space Products, Int'l, 5310 Derry Avenue, Agoura, CA 91301 (phone 800-638-2581). Based on our experience with the first batch of cups, we would order $1\frac{3}{8}$ " \times $1\frac{3}{8}$ " \times 0.005" sheets in the future (providing 6 cups per strip).

Cleaning the Ta Sheets:

Prior to beginning the operation the tantalum sheet must be cleaned. Each sheet should be cleaned ultrasonically, first using a fresh batch of 1,1,1 trichloroethane for 15 minutes. Then it should be transferred to a second bath of fresh acetone and ultrasonically cleaned for 15 minutes. Finally, transfer the sheet to a third bath of fresh methanol and ultrasonically clean it for 15 minutes. The sheet is then blow dried with filtered dry nitrogen, taking care to ensure that there is no dust. The material should only be handled with cleaned stainless steel tweezers, and UHV gloves should be worn to avoid any possibility of fingerprints on the material. Store the blank sheets in a cleaned plastic box lined with lint-free paper - one sheet of tantalum per compartment. This procedure is most easily carried out at the laboratory prior to bringing the material to Action Tool and Die.

Also prior to the visit, a clean plastic box with appropriate compartments to hold the finished cups should be fabricated (we used a cabinet purchased from McMaster-Carr - their # 4629T34)

Blanking and Drawing the Cups:

At Action Tool and Die, begin by cleaning the die sets with 1,1,1 trichloroethane, then acetone, and then methanol, following the procedure outlined above for the Ta sheet. Handle the die parts only with UHV gloves. All of the blanking, drawing, and punching operations are to be carried out using only isopropyl alcohol as a lubricant, and the material must always be handled with clean stainless steel tweezers and/or UHV gloves. Cleanliness cannot be stressed enough. The smallest piece of dust or dirt will be enough to damage the surface and cause the blank to be a reject. Also, do NOT use any oil for the manufacturing process; it is unnecessary, and can lead to disaster with the operation of the gun.

The first operation is the blank and draw operation. Approximately 45 cups can be fabricated from each 12" x 12" sheet of tantalum. Only isopropyl alcohol is to be used as a lubricant; squirt a liberal amount on the sheet where the die will strike for each and every cup. As each cup is formed place it in the compartmented box wrapped in lint-free paper—one blank per compartment.

After many draws (typically 25-50) the lower portion of the die, the ring with the high polish inside and the top radius, must be re-polished. A re-polish is needed when the cups are deformed and/or small pieces are broken off. Alternately, it is needed if the outside of the cups begin to show many scratch lines. Scratch lines indicate that the cup is dragging in the die. Re-polish the die using a diamond-impregnated Cratex stick (#6606XF extra fine). Re-clean the ring and other parts as necessary, and continue to draw cups.

Punching the Hole in the Cup:

Begin by cleaning the die parts using 1,1,1 trichloroethane, then acetone, then methanol,

following the procedure outlined above for the tantalum. There must be no residues and dirt on the surface, and there must be no dust or lint on it. Clean each cup prior to mounting it on the die by squirting it generously with isopropyl alcohol. Then push the cup onto the lower die and seat it. Clean the upper part of the punch by squirting it with isopropyl alcohol, and then punch the hole by activating the pneumatic drive. Release the pressure to retract the upper part of the punch. The cup will "pop" off of the seat; use tweezers to remove the cup from the die. Inspect the cup's top surface for any defects. If a defect is found (a bump pushing up means there is dirt on lower die or dirt inside cup; a dent means there is dirt on upper die or dirt on top of cup), re-clean the dies and continue to next cup. The key to good Ta cups is to keep all dies and material clean.

After the hole has been punched return the cup to the compartmented box wrapped again in lint-free paper.

Finally, upon return to the laboratory, each of the finished cups should be removed from the box, inspected carefully, cleaned using 1,1,1 trichloroethane, acetone, and methanol as in the original procedure for cleaning the tantalum, and then wrapped in a fresh piece of lint-free tissue and returned to the storage box until you are ready to use it. Alternately, for greater convenience, follow the procedure outlined below for long-term storage.

Alternate Procedure for Long-term Storage:

It will save time during the cathode-changing procedure if the Ta cups have been cleaned and stored in clean, sealed, nitrogen-filled, poly bags. This can be done by preparing three ultrasonic cleaning baths: one of fresh 1,1,1 trichloroethane; one of fresh acetone; and one of fresh methanol. Remove the cups (one at a time) from the storage box. Inspect them carefully, and then ultrasonically clean for 15 minutes in 1,1,1 trichloroethane. Transfer to the acetone bath and ultrasonically clean for 15 minutes. Finally, transfer the cup to the methanol bath and ultrasonically clean for 15 minutes. The cup is then blow dried with filtered dry nitrogen, taking care to ensure that there is no dust. Blow the dry nitrogen into a clean poly bag, place the tantalum cup in the bag, and heat seal it. Throughout this procedure the cups should only be handled with cleaned stainless steel tweezers, and UHV gloves should be worn to avoid any possibility of fingerprints on them. Store the bagged cups in a cleaned plastic box lined with lint-free paper that is, in turn, stored in the nitrogen-filled dry box. Take care to keep the bagged cups separated. This procedure is most easily carried out at the laboratory after returning from Action Tool and Die, and it is probably best to first clean and store the cups as outlined above, and then follow this cleaning and "bagging" procedure on a large quantity of the cups at a single time.

