Tungsten Cathode Processing

1. Cut cathode to size from 75% W - 25% re-wire, 0.030" dia.; body length is 0.047" ±0.005" (sec A69982-6220).

2. Deburr cathode blanks in a ball mill using #3 aluminum oxide slurry. Use enough glycerine to make a thin mixture. Rotate ball mill at 150 RPM or faster for 2 hours. Burrs should be within tolerance on drawing A69982-36A-6220.

3. Rinse off slurry after milling with D.I. water and clean in acetone agitated by an ultrasonic tank.

4. Elox cathode blanks as per drawing A69982-6220.

5. Cleaning after eloxing:
   (a) Vapor degrease bodies in a basket whose mesh is small enough so that none can escape into tri-chlorethylene bath.

   (b) De-ionized water boil (minimum boiling time 5 minutes).

   (c) Ultrasonic rinse in AR grade acetone.

   (d) Repeat steps (b) and (c).

6. Firing of Tungsten bodies after chemical cleaning.
   (a) Load cathode bodies in a molybdenum crucible and place inside a Tungsten coil.

   (b) Lower Bell jar and flush with argon for 3 minutes.

   (c) Start flow ofwwet hydrogen (use hydrogen water bubbler) at a rate of 8 c.f.h.

   (d) After 3 minutes, turn on power to Tungsten coil and adjust current until a visible glow is obtained(about 700°C Br).

   (e) Increase power at a rate of approximately 100°C Br per minute until a temperature of 1000°C Br is reached. Hold at this temperature for 3 minutes.

   (f) Turn off power and cool in wet hydrogen atmosphere for 10 minutes (thin crucible).

   (g) Turn off hydrogen and flush with argon for 5 minutes.

   (h) Raise Bell jar and remove crucible.

   (i) Store fired bodies in a clean covered Petri dish.

7. (a) Load 6 wet hydrogen-fired cathode bodies in a suitable metal holder and align the hole of one of the bodies under the emission mix packing punch. Set up should be such that holder can be locked in place after alignment.

(b) Punch should apply a 2 lb. pressure to a 0.010" dia. end. Test alignment by inserting punch into cathode body.

(c) Using a hood; mix a small quantity of emission mix ((76% W + 24% Th) +20.3% WC) with enough butyl carbitol to wet mix to a paste. Use a glass container to hold paste.

(d) Transfer emission mix paste to working area and place a small amount of mix over the hole in the cathode body under the punch.

(e) Lower punch until it packs the mix in the bottom of the cathode hole. Use full 2 lb. pressure. Repeat steps (d) and (e) until mix is packed flush with top surface of cathode.

(f) Repeat steps (a), (b), (d) and (e) for each of the other five cathodes.

(g) Remove packed cathode bodies from holder and roll each body on alcohol-wetted lintless paper to remove loose emission mix from sides and bottom of cathodes.

(h) Store packed bodies in a clean Petri dish lines with a sheet of fired tantalum.

8. (a) Place packed cathode bodies in a small tantalum crucible that, in turn, is placed inside a tantalum bucket. The bucket is placed inside a quartz Bell jar (suspended from a hook in the top of the Bell jar).

(b) Evacuate Bell jar to 5×10^{-5} Torr or lower. Place the RF coil (water-cooled) around the section of the Bell jar containing the bucket. Use a fan to cool Bell jar during RF heating.

(c) Turn on power to RF coil (zero setting on variac) and raise temperature slowly. Sinter cathode bodies as per the following schedule:

1. 0°C to 450°C - in 1 hour (linear rise in temperature is necessary).
2. 450°C to 800°C - 1/2 hour - linear rise in temperature.
3. 800°C to 1700°C - 5 minutes.
4. Hold at 1700°C for 15 minutes.
5. Turn off RF power and allow cathode to stand under vacuum for 30 minutes before removing from vacuum.

(d) Handle cathode bodies with clean tweezers and <u>do not jar them at any time</u> as it might loosen emission mix.

(e) Store sintered cathodes in a clean covered petri dish.

9. Grind cathode bodies until top surface is perpendicular within 1° of vertical axis of body. Surface finish should be as smooth as possible - remove as little metal as is necessary to satisfy the above requirements.

(a) Use a Dumor, or equivalent, grinder firmly mounted to the tailstock or ways of a precision lathe. The grinding wheel to be used is specified as follows:

American Chain & Cable Co.
Bridgeport, Conn.

Cut off wheel
AZ40QR-A7
1" dia. X0.010" x 1/8 hold dia.

} or equivalent

(b) Provide a clean collet to hold cathode body firmly on axis of lathe headstock and adjust grinding wheel off axis of headstock so that side of wheel may be used for grinding. Axis of grinding wheel to be parallel to lathe ways.

(c) Insert a cathode body with clean tweezers in collet and tighten collet. Check runout with a dial indicator. Rotate lathe at 8-1200 RPM.

(d) Turn on grinder and dress wheel. Wheel should be dressed before starting to grind each cathode.

(e) Advance grinder until side of wheel just touches end of cathode. Not more than 0.001" to 0.002" metal will have to be removed and thus a very smooth finish can be obtained with little or no pressure to side of grinding wheel. (These wheels will break easily). Grinding must be done dry without any grinding compounds.

(f) Examine ground cathode with a microscope or 20X glass - finish should be free of burrs and no cathode mix should be loose or have dropped out of hole.

(g) Use tweezers to remove cathode body from collet and store in clean covered Petri dish. Do not let cathode bodies come in contact with contaminents such as oil or human hands at any time during grinding process.

10. Form rhenium leg blanks to shape indicated on drawing A69982-36A-6251. A die lubricant that is soluable in trichlorethylene often facilitates forming. Long axis of rhenium leg blank must coincide with axis of formed rhenium legs or otherwise cathode will not mount properly to ceramic stem (see B69982-36A-6254).

11. Clean rhenium legs as per step 5 of these instructions. Store cleaned rhenium legs in a clean covered Petri dish.

Welding Procedure:

(a) Use tweezers to place cathode body and rhenium leg assembly on to tantalum leg stem. Note: Careful handling will allow these assemblies to be mated and the spring tension of the rhenium legs will hold the assembly together temporarily. A precision fixture is needed to hold the stem and allow a mandrel to apply gentle pressure on the top of the cathode body to adjust the height above the stem ceramic.

(b) Use above mandrel with a pre-adjusted stop collar to set cathode heights and alignment.

(c) Remove mandrel with stop collar and tack-weld one rhenium leg to the tantalum stem support.

(d) Replace mandrel with stop collar and recheck cathode height and alignment. Readjust free leg, if necessary, and tack weld.

(e) Make 10 good welds to each rhenium leg in area of contact with tantalum support. Use molybdenum electrodes (alcohol not necessary). Use same welder as specified above. Typical setting as follows: 4 cycles - 25% heat adjustment.

(f) Inspect welds and then remove cathode assembly from fixture and store on a clean ceramic cylinder in a suitable covered container such as a glass weighing bottle.

15. Place a number of cathodes in a vacuum system (electrical hook-up is in series) and pump down to at least 2×10^{-6} Torr (use liquid nitrogen trapping). Cathode to be heated slowly to obtain initial permanent set of rhenium legs. Cycle cathode temperature to test welds.

Schedule as follows:

(a) Heat cathodes linearly at rate of 1 amp./minute until a current of 5.6 amp is obtained through rhenium legs. Hold for 10 minutes at temperature (5.6 amp corresponds to 1600°C Br - 1650°C Br temperature).

(b) Cool cathodes at same rate as indicated in step (15 A).

(c) Heat cathodes to temperature rapidly and cool rapidly until visible color disappears.

(d) Repeat step (15c) (cathode cyling) for 5 cycles.

(e) Hold cathodes at temperature at end of 5th cycle for 10 minutes.

(f) Cool cathodes under vacuum for 30 minutes - remove and store in weighting bottles.

16. Cathode Inspection:

(a) Inspect cathode assembly for cracks in emission mix, faulty spot-welds and general appearance.

(b) Check cathodes on optical comparator for specifications as per drawing B69982-36A-6254 and ±1° tilt spec mentioned above. Also eccentricity of ±0.010".

(c) Store completed cathodes in glass weighting bottles with identification labels. Label should show a code number that defines the parts, emission mix and any non-standard procedures used in constructing the cathode.

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