

Procedure For Copper Black Coating

(updated for changes to vacuum chamber)

Surface Preparation - Place the machined aluminum pieces in an ultrasonic cleaner with MC-3 metal surface cleaner from Branson. Fill the bath to the fill line, make it warm (~50C), and degas for at least 10 min. Set the cleaner to operate for 10-15 min. Insure the detector pieces do not rub and/or touch. Flip pieces midway though cleaning and brush drilled holes periodically. Rinse and blow dry. Blow off pieces with clean air to remove dust particles before placing them in the chamber.

Vacuum check – Make sure the inside of the vacuum is cleaned before placing a piece inside. The rubber seal and the ring where the bell jar meets the base plate should be cleaned well. Smear a small amount of vacuum grease around seal when needed. Also clean the molybdenum wire (0.01 in dia) and the copper you wish to evaporate (0.02 in dia; 99.999% purity) by sanding with fine sand paper and by rubbing with alcohol. Make the number of filaments you wish to use on the jig. Install them in parallel. Cut and shape the copper into a small “v”(total length ~0.4 in). Hang each “v” on a dip in the wire. Now place your piece in the chamber.

Placement of piece - The chamber can either be set up to evaporate metal onto a piece above or below the filaments. Both ways produce similar results, however the size and shape of the piece needs to be considered. Especially for copper black, the distance from the filament is critical. It is also dependent on the pressure one uses to backfill with Nitrogen. Keep in mind there are numerous options. Do not put the piece directly under the filament as drops of molten copper can fall onto it. For a backfill pressure of ~115mT, a distance of 3-4in away from the filaments works well. Large pieces can be tilted at an angle for better coverage. When the piece is hung above it can be right above the filament, but care must be taken not to evaporate too quickly. The piece can also be swung above or below the filaments with the feed-through. If it is not at the base of the chamber, insure the item to be coated is grounded.

Pump Down - Rough out the fore line and insure it is below 100mT (flip foreline switch up). Turn on diffusion pump and let it pump for at least 20min before putting liquid nitrogen in cold trap. Always check to insure fore line is always under 100mT. Turn Ion Gauge on. Wait until the gauge gets down to 10E-6 range. Now rough out the bell jar by flipping the foreline switch off and the roughing switch on. Once bell jar is under 100mT you can open to diffusion pump (NEVER before!!) by flipping the roughing switch off and the foreline switch on and turning the high-vac valve to the ‘on’ position. Wait for pressure to drop to low 10E-5T range or lower.

Procedure - Before a copper black coating is applied a uniform shiny layer of copper needs to be deposited at high vacuum. This layer is more conductive than the aluminum oxide underneath and it is less reflective to UV light.

Shiny- Once the bell jar is under high vacuum turn the current supply on (click evapitrol switch up and turn knob clockwise). The supply should be turned up slowly until all the copper has wetted to the filament. Turn the supply up slowly again

turning it up too fast tends to make the molten copper sputter out in large blobs). It can be turned all the way up if needs be. Deposit desired amount or until all copper is evaporated. Slowly turn current to filament down and off. Turn hi-vac valve off, flip the foreline switch off, and flip the vent switch on. Keep one hand on the bell jar to make sure it does not shoot upwards. Inspect your piece. To insure uniform coating it may need to be rotated and recoated.

Black- Once the piece has a layer of shiny copper, the filaments can be reloaded and the chamber can be pumped down again. Once high vacuum is attained the copper should be carefully melted but NOT evaporated. Keep current at that setting. Quickly switch to ROUGH by shutting hi-vac valve and flipping foreline switch off and the rough switch on. and watch the thermocouple gauge. Open the black valve at the back of the chamber to allow the Nitrogen in through the needle gauge. Close it as you approach 115mT. Stay between 110 and 125 by opening and closing that black valve. The needle valve may need to be adjusted to allow the right amount of bursts into the chamber but that should be done before the blacking process is started. The correct Nitrogen pressure needs to be attained quickly, as the molten copper is always evaporating. Turn the current up slowly and deposit until the filaments are clean. Turn the current down and off. Turn the Nitrogen valve off. VENT the chamber. Inspect piece. It may need to be rotated and recoated.

Inspection- The shiny coating is fairly durable. Avoid touching it and always wear powder-free gloves when handling the detector pieces. Each one should be on temporary legs and those are good to hold with pliers. Look at the edge of the piece. If there is any area that you can see the aluminum through, recoat. If there are any molten blobs of copper, knock them off carefully with ceramic tweezers. If in the process the coating is scratched, recoat. The black copper is extremely light and fragile. One touch with the glove will ruin the coating. When the coating is compromised, the piece needs to be cleaned to the copper layer with lint-free wipes and clean blown air. Alcohol can be used but is not recommended once the copper coating is on the aluminum. Again look for molten blobs of copper that sputtered off the filament. It is of utmost importance these are removed as they could cause a short once the detector is assembled. Use the same procedure as described above and recoat if black layer is scratched.

Storage- Store all detector parts in a Nitrogen purge box. Humidity should be kept very low (below 10% is preferred). Keep the parts from touching and watch stray wires and holes in the box surface as they lead to damage to the coating. Always keep coated parts on their legs/standoffs for easy handling.

Shut down- When finished for the day, ROUGH out the bell jar a bit to keep interior clean. Turn off diffusion pump and make sure the fore line is roughed for at least 30 min before shutting down the roughing pump. Shut off nitrogen tank.