thermionics laboratory, inc.

INSTRUCTION MANUAL

e-Gun™ Operations

Version 2

SERIAL # _____

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Crucible Preparation

Cleanliness is critical for high quality films and trouble-free operation. CLEAN the crucible thoroughly before each new material is used. Heavy buildup of the previous material on the crucible can cause contamination of the melt. The crucible should be cleaned by using an abrasive pad (“scotch bright”) and then vacuuming out. It should then be wiped out with acetone and alcohol. Cleaning by glass bead blasting is another alternative. When using a glass bead blaster make sure to keep the air pressure at 40psi. The source should be disassembled prior to glass bead blasting and special attention should be given to removal of all glass from the parts after cleaning (glass is a dielectric material and will cause severe arcing if left on the source).

Choosing Evaporation Material

Material for evaporation comes in a variety of forms and purities. Typically, purity will be determined by the process. Thermionics typically recommends using 5 to 8mm (or larger) granule material. This material form is readily available and allows you to add material as it is depleted from the crucible. Starter charges are also available from many manufactures. Although they provide a dense original charge of material, they can contain impurities that might otherwise be “degassed” during the melt down of a granule type material. Powders can be used but are not recommended. Powders can “splash/spit” during initial heating making them difficult to melt.

Filling the Crucible

Running the e-Gun with an empty crucible will destroy the source. Fill the crucible with evaporant material. If you are using granules, pack the crucible and form a “slight” dome. As the granules melt, they will fill in the voids and you should have a full crucible. Make sure not to overfill the crucible, the top plate must have clearance to turn. It is best to operate the source with the crucible filled between 20% and 100% (for liners see below).

Filling a Crucible Liner

Crucible liners add a thermal barrier between the evaporant material and the water-cooled crucible. Liners also prevent build up of coating on the e-Gun and reduce the need for cleaning. Overfilling a crucible liner is the number one cause of failure (cracking). Fill liners between 20% (minimum) and 80% (maximum) unless evaporating Aluminum (70% maximum fill). Make sure that all material is carefully stacked into the liner. If material "spills" over the top of the liner and touches the water-cooled copper it will destroy the liner.

Final Check Prior to Pumpdown

1. Turn on the water and check visually for leaks.
2. Make sure the crucible is loaded with material.
3. Move the crucible block to all pocket positions and verify that there is no interference from the evaporant material. Note which crucible you leave the source indexed to.
4. Visually check the high voltage and sweep leads making sure you have ½ inch clearance around all high voltage leads. Make sure the sweep leads do not pass directly behind the source (if they must make sure to install a grounded shield around them to prevent any contact with secondary electrons).

At this point you are ready to pump down the system.

e-Gun™ Operation

1. Make sure the vacuum chamber is operating at a pressure less than $5x10^{-4}$ Torr.
2. Make certain all interlocks are operating properly. All grounds must be secure.
3. Turn on the e-Gun cooling water (this should be interlocked to the high voltage power supply).
4. Assure desired crucible is selected and properly located.
5. Set the power supply emission current potentiometer to zero.
6. Turn on the power supply and check to see that all interlocks are satisfied.
7. Turn on the high voltage.
8. Slowly increase Voltage to –10,000 VDC. If arcing is observed, stop and let the unit sit until stable. If arcing does not stabilize reduce Voltage and re-check all HV connections and leads for proper spacing. Check Vacuum is below $5x10^{-4}$ Torr and the system is properly grounded.
9. Turn on the emission current and slowly increase the potentiometer until you see a slight glow on the crucible. This will normally appear as a blue glow at an emission current of about 20 to 30 milliamperes. Slowly increase the power to 50 milliamperes (or until you can clearly see the beam spot).

Note: The e-Gun is factory set to locate the beam just off the center of the crucible. If the beam is not close to center: If you have a variable voltage power supply, adjust the voltage to center the beam or use the x-y sweep position controls to center the beam. If you do not have variable voltage or a sweep controller you will need to make magnetic adjustments to the e-Gun. Contact the factory for adjustment procedures.

Depositing Materials That Melt

After following the above procedure (steps 1 through 8). Continue to slowly increase power in 20 to 30 milliamp increments. If the material appears unstable, flickering light or waves in the melt, stop and let it set until it re-stabilizes (you may have to reduce power if stability cannot be restored). Arcing will occur and is normal in e-Gun evaporation, stop increasing power when arcing is observed and let the source soak until arcing stops. Arcing is normally caused (on melting materials) by outgassing. Continue to increase power until reaching the desired rate.

Note: Oxide formation can prevent an evaporant charge from melting in some cases. Some metals (aluminum and copper are examples) will form an oxide that prevents melting and causes the beam to appear unfocused. When this occurs, you can invert the melted slug and re-melt it to remove the oxide –or- replace the charge with fresh material.

Depositing Materials That Do Not Melt (Sublime or Semi-Sublime)

Subliming materials require beam sweep. All HC e-Guns™ are equipped with electro-magnetic coils for this purpose. Digital and programmable sweep generators are available as optional items and are required to perform beam sweep functions.

Note: Some subliming materials will not support electrical current until heated. This causes surface charging on the material that results in arcing. The surface charging effects can also cause the beam to be "scattered" behind the crucible and onto the top plate of the e-Gun. This is normal with some materials. The e-Gun top plate is designed to dissipate this energy. To evaporate materials that have surface charging effects you must increase the "soak" times of the electron beam as you increase power. If you allow the source to set at a power level of ~50 to ~75 milliamperes for an extended time (make sure arcing is not severe) the material will eventually be heated sufficiently to "fire" and the beam will stop scattering beyond the crucible. You will in many cases still see some hazing on the e-Gun source (this is normal) during evaporation. As the e-Gun becomes coated with these materials hazing may increase.

e-Gun Shut Down

Once the desired rate is achieved, close shutter (if so equipped) or reduce emission current to zero. Turn off high voltage. Allow adequate cooling time prior to venting the system. The e-Gun must be allowed to cool off for at least 5 minutes unless venting to an inert gas to protect the filament. Most metals will cool down quickly ~5 minutes unless they are used in a crucible liner. Subliming and dielectric materials or metals used in insulating liners require additional cool down time. Normally 20 minutes will be adequate although conditions can vary.

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