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Processing of Dispenser Cathodes

The processing of a dispenser cathode is quite straight forward especially if a few simple guidelines are followed. Cathode storage, cathode handling, contamination, humidity, pumping speed, vacuum level, pump location with respect to cathode, bakeout temperature, cleanliness of tube components and preprocessing history will all influence the time to process a cathode but will not really otherwise effect the process steps.

A critical consideration is to protect the cathode from either being poisoned or from poisoning itself.

Storage

As shipped, the cathode is in a protective package. This is either a glass vial under vacuum or in a vapor barrier soft pack backfilled with dry inert gas (N2 or Ar). Though both are suitable for shelf storage up to one year, HeatWave Labs recommends that each unit be inspected upon receipt. If units have arrived damaged, or are otherwise thought to be defective, HeatWave Labs must be notified within 30 days of shipment.

After inspection, units can be stored under vacuum (10-3 Torr) or in dry, inert gas.

To protect the cathode from poisoning from the surrounding structure or from the gas products during bakeout, two steps are important:

1. Maintain adequate vacuum level at the cathode. The key here is *"at the cathode"* and not downstream at the gauge. There is often a very large pressure drop between the cathode and the gauge. The pressure at the cathode must be $1x10^{-6}$ Torr or better at all times. As heater power is applied to the cathode for the first time, the pressure will increase as the temperature rises. If the pressure goes above $1x10^{-6}$ Torr, back off on the power to the cathode until the pressure recovers. This outgassing can take as long as a few minutes for a small point source emitter to several days for very large Klystron Cathodes.

2. Throughout the processing and bakeout process, keep the cathode temperature at or above the tube temperature. This will minimize any sublimation of evaporants from the tube onto the cathode.

To protect the cathode from poisoning itself, the following steps must be taken:

Moisture has the potential of permanently poisoning the cathode. If a cathode is ramped in temperature at such a rate that the moisture cannot escape, hydroxides and carbonates can form which not only reduce emission capabilities but also cause blistering and cracking of the tungsten emitter surface.

To prevent this, a cathode must be allowed to soak at 200-400°C long enough to allow complete outgassing of the water vapor. Pressure again will be a good indicator of the gassing rate. Keep the pressure at $1x10^{-6}$ Torr or better even at these low temperatures. This low temperature soak is especially important if the cathode has been exposed to air or humidity for an extended period.

Activation after tube outgassing and bakeout:

Activation is achieved by converting the Barium Oxide in the tungsten matrix into free Barium on the surface of the cathode. The rate of activation is a function of tube cleanliness, cathode poisoning, time and temperature. All systems are different so there is no "standard" activation schedule. In general, the cathode is activated at or slightly above (+50°C) the operating temperature. Cathode electron emission is the best indicator of activation. The cathode temperature should never exceed 1200°C. Activation is also possible at lower temperatures (950-1000°C) but it will take longer.

Reactivation after air exposure:

A dispenser cathode can be used over and over if exposed to dry air while cool. The same considerations as mentioned above must be followed. The only difference is the outgassing time may be reduced. Also, the once activated cathode will be very reactive when let up to air. The cathode will be exceptionally sensitive to humidity and contamination. It is best to let the tube up to dry Nitrogen or another dry, inert gas.