Standard Operating Procedures

Electron Beam Evaporator

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Important

- Gloves should be worn while handling substrate and deposition to reduce contamination.
- Always rotate the "Output Voltage" and "Emission" dials slowly to avoid an arc fault or possibly burning out the filament.
- Always clamp the chamber door shut; failure to do so can result in machine breakdown.
- You can only use CeNSE laboratories and equipment if you have been approved by Brian or Chuck, reserved the tool on the calendar, and filled out a form. No Exceptions!
- If the equipment is acting unusual STOP! Please discuss with Brian or Chuck before proceeding and leave a note on the machine.
- Any accidental damage must be reported immediately.
- All CeNSE laboratories are protected by video surveillance.

Machine Exterior (excluding chamber)

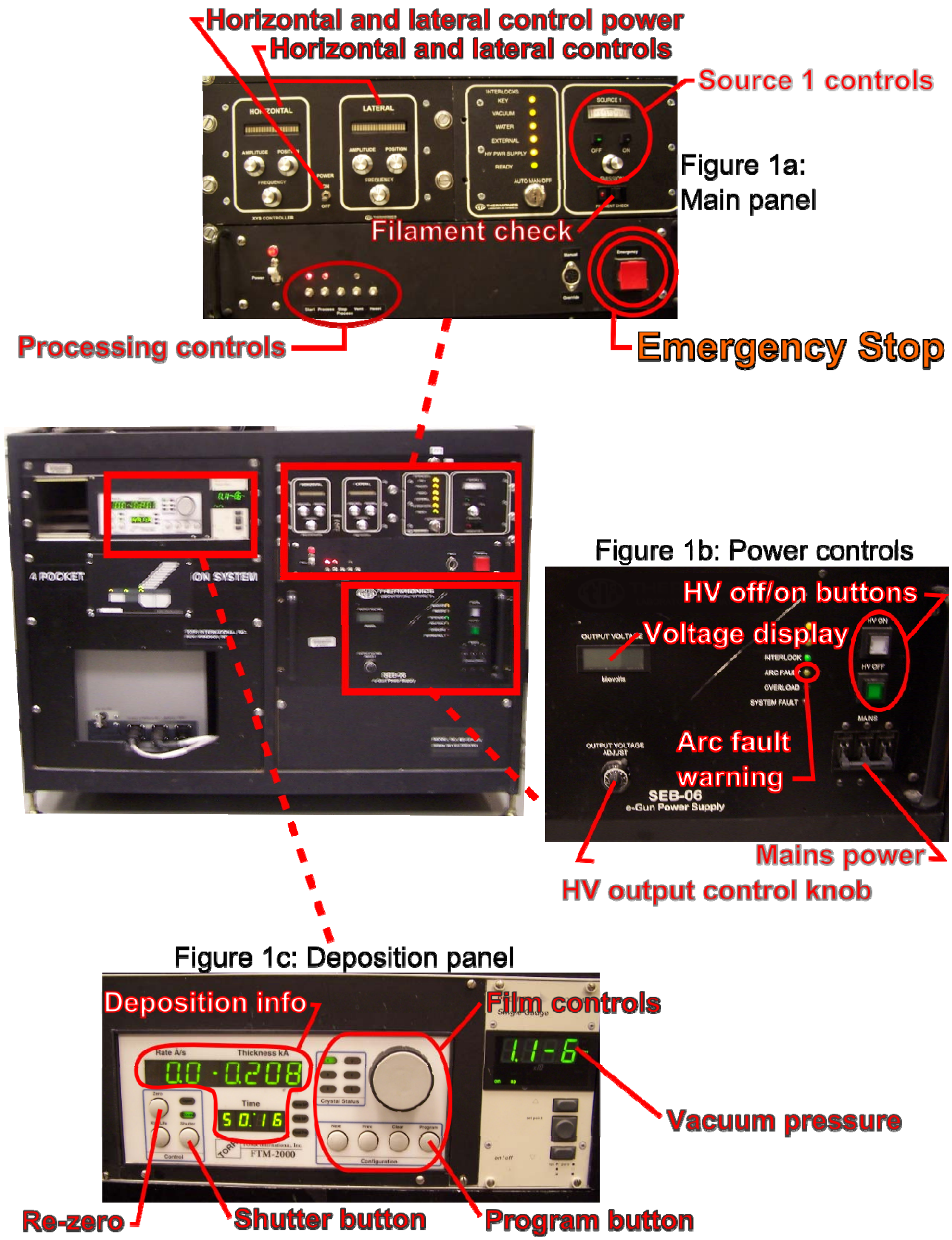


Figure 1a: Main panel

Figure 1b: Power controls

Figure 1c: Deposition panel

Chamber Exterior and Interior

Figure 2a: inside the chamber

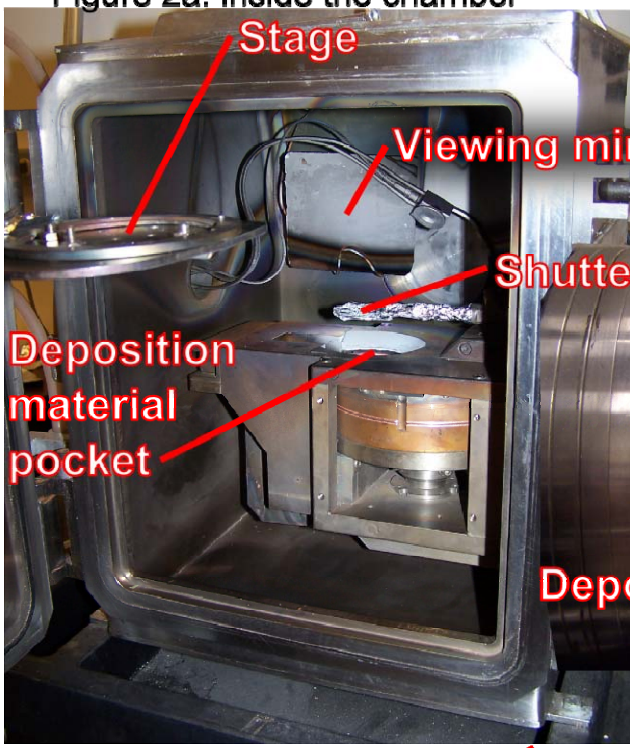
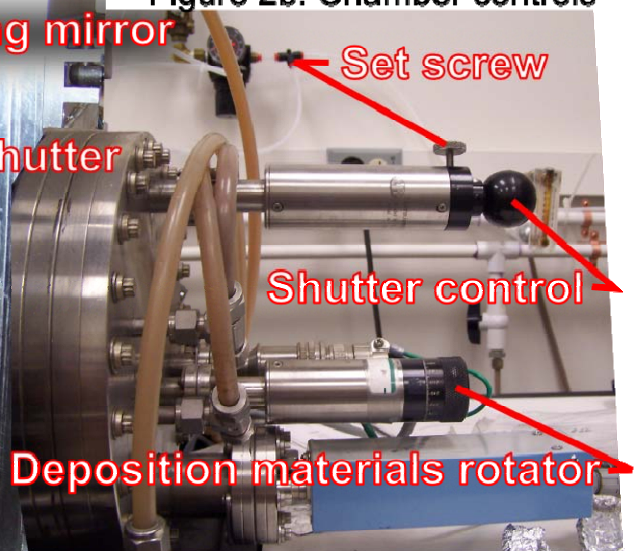


Figure 2b: Chamber controls



Operating Procedure

1. Preparation

1.1. Before beginning, be sure to wear gloves to reduce contamination and to protect the hands.

1.2. Place each deposition material into a crucible. Crucibles should be marked for their specific deposition material.

2. Load the sample

2.1. Open the chamber door:

2.1.1. Unlock the chamber by releasing the four clamps that hold it in place.

2.1.2. Press the “stop process” button on the processing controls (figure 1a).

2.1.3. Press the “reset” button on the processing controls (figure 1a).

2.1.4. **Wait 1-2 minutes for the pressure to stabilize** before proceeding.

2.1.5. Press the “vent” button on the processing controls (figure 1a).

2.1.6. Wait for the chamber to vent. The door should open slightly when this is complete.

2.1.7. Press the “reset” button on the processing controls (figure 1a).

2.2. Clamp the substrate to the stage:

2.2.1. Open the chamber door fully.

2.2.2. Remove the mounting screw on the underside of the stage (figure 2a).

2.2.3. Slide the stage out from the holder (figure 2a).

2.2.4. Clamp the substrate to the underside of the stage using the spring clamps.

2.2.5. Replace the stage and mounting screw.

2.3. Insert deposition materials:

2.3.1. Remove the shutter by pulling toward left side of chamber. (figure 2b).

2.3.2. Insert the crucible with the deposition material (not more than 2/3 full) into the deposition material pocket (figure 2a). To use multiple materials, turn the deposition materials rotator one full rotation to open a new pocket.

2.4. Check the condition of the thickness monitor sensor. Press the “Crystal” button found on the thickness monitor (figure 1c).

2.4.1. If the display shows less than 75% let a CeNSE staff member replace it for you. It is still usable at this point. If no one is available to replace it you can send a CeNSE staff member an email

2.5. Close the chamber:

2.5.1. Replace the shutter. Just slide it back into the fitting. (figure 2b)

2.5.2. Close the chamber door.

2.5.3. Tighten the four door clamps.

2.6. Pump down the chamber

2.6.1. Press the “start” button on the processing controls (figure 1a) to start the low vacuum pump.

2.7. **Wait until the vacuum pressure is below 5×10^{-1} Torr**; it is then safe to continue.

Operating Procedure, continued

2.8. Press the “process” button on the processing controls (figure 1a) to start the high vacuum pump.

3. Configure the deposition thickness monitor

3.1. Press the “program” button on the deposition panel (figure 1c).

3.2. Using the dial on the film controls (figure 1c), select the film number that corresponds to the deposition material in the table in Appendix A.

3.3. Press the “next” button (figure 1c). This will load the material parameters into memory. Ensure that the material parameters match those listed in Appendix A.

3.4. Press the “program” button again to save the selection (figure 1c).

4. Configure for deposition

4.1. **Wait until the vacuum pressure is below 5×10^{-5} Torr**; for best results wait longer for pressure lower than 9x10-6Torr.

4.2. Press and hold the “filament check” switch under the source 1 controls (figure 1a) until a glow can be seen through the chamber window. Once the glow is visible, release the switch.

4.3. Turn on the power:

4.3.1. Switch on the horizontal and lateral control power (figure 1a).

4.3.2. Enable (flip upwards) mains power on the power controls (figure 1b).

4.3.3. Press the “HV on” button on the power controls (figure 1b).

4.4. Set the desired output voltage, in kV, by rotating the HV output control knob **slowly** (fig 1b). Rotating the knob too quickly will result in an arc fault.

4.4.1. If you have an arc fault you will need to turn the power back to 0kV.

4.4.2. Press the “HV off” button.

4.4.3.Go back to 4.3.3.

4.5. Press the “on” button for the source 1 controls (figure 1a).

4.6. **Slowly** rotate the “emission” dial (figure 1a) until you can see a pressure change.

4.7. Continue to increase the current until the beam spot can be seen. Sometimes it can be hard to find. Try wiggling the vertical or horizontal position control.

4.8. Aim the electron beam:

4.8.1. Look through the viewing mirror at the glowing spot formed by the electron beam.

4.8.2. Adjust the <u>location</u> of the beam by using the horizontal and lateral “position” dials (figure 1a).

4.8.3. Move the beam in to the center of the crucible.

4.8.4. For materials that sublimate or are poor thermal conductors (e.g. carbon).

4.8.4.1. Adjust the <u>area of coverage</u> by using the “amplitude” dials (figure 1a).

4.8.4.2. Adjust the <u>frequency</u> of the beam’s movement by using the “frequency” dials (figure 1a).

4.9. Now heat up the deposition material until it glows dull orange.

4.9.1. Optional: Leave it at this point for a minute or two and see if the vacuum recovers. If it does continue to wait until it stabilizes. This helps degas the deposition material.

5. Deposit material:
   5.1.1. Continue to adjust to the desired deposition rate.
      5.1.1.1. Technique is everything. It is hard to get a consistent deposition rate. The tendency is to overshoot or undershoot the desired rate. Unless the deposition rate is going up very fast, make very small changes and wait a minute for the change to occur. Remember that even though the change in current is instant, the change in the temperature isn't. One way to tell how far off you are from your ideal rate is how fast it is changing. When you are close, the rate change slows. Additionally, as your deposition material is being used up the current per unit area increases causing a slow increase in deposition rate. Nope. You can't walk away.
   5.1.2. Open the shutter release the set screw, pull the shutter control open, and tighten the set screw (figure 2b)
   5.1.3. Quickly press the "zero" button (figure 1c) to re-zero the deposition thickness measurement.
   5.1.4. Wait until the desired deposition thickness is achieved.

Operating Procedure, continued

6. End Deposition
   6.1. Close the shutter by releasing the set screw, replacing the shutter control, and tightening the set screw again (figure 1c).
      6.1.1. Note: The vacuum wants to pull it back in. Be careful to slide it in slowly. Failure to do this will cause the shutter to fall in the chamber. This inevitably causes contamination and possibly expensive repairs.
   6.2. **Slowly** rotate the source 1 "emission" dial (figure 1a) until the indicator reaches zero.
   6.3. Press the "off" button on the source 1 controls (figure 1a).
   6.4. If performing multiple depositions, configure the new deposition as described in **steps 3.1-3.3**, turn the deposition materials rotator 360°, and begin the next deposition from s**tep 5.4**.
7. End processing
   7.1. Turn off the power:
      7.1.1. Switch off the horizontal and lateral control power (figure 1a).
      7.1.2. **Slowly** turn HV output control knob (figure 1b) until the output voltage reaches zero.
      7.1.3. Press the "HV off" button on the power controls (figure 1b).
      7.1.4. Disable mains power on the power controls (figure 1b).
   7.2. **Wait at least 20 minutes** for the chamber to cool before proceeding.

7.3. Open the chamber door:

7.3.1. Unlock the chamber by releasing the four clamps that hold it in place.

7.3.2. Press the "stop process" button on the processing controls (figure 1a).

7.3.3. Press the "reset" button on the processing controls (figure 1a).

7.3.4. Press the "vent" button on the processing controls (figure 1a).

7.3.5. Wait for the chamber to vent. The door should open slightly when this is complete and you may here the hissing of the N2 purge gas.

7.3.6. Press the "reset" button on the processing controls (figure 1a) to stop the purge gas.

7.4. Open the door; remove the substrate (see **step 2.2**) and crucible(s).

8. When you are done with the machine

8.1. Close the chamber door and tighten the clamps on the (now empty) chamber.

8.2. Press the "start" button on the processing controls (figure 1a).

8.3. **Wait until the vacuum pressure is below $\mathbf{5 \times 10^{-1}}$ Torr**; it is then safe to continue.

8.4. Press the "process" button on the processing controls (figure 1a).

Appendix A: Film selection

This table is used in step 3.2 to determine which film to select.

Film Number	Deposition Material	Density	Z-Ratio
Film 1	Aluminum	2.70	1.08
Film 2	Titanium	4.50	0.628
Film 3	Copper	8.93	0.437
Film 4	Gold	19.3	0.381
Film 5	Silicon	2.32	0.712
Film 6	Nickel	8.91	0.331
Film 7	Platinum	21.4	0.245
Film 8	Silicon Dioxide	2.648	1.00
Film 9	Custom	*See below*	

Using film 9 to set your own deposition material:

1. Refer to the next pages for material properties for your deposition material.
2. **Use only film 9 for custom settings. Never change the settings for films 1-8.**
3. When setting the film number as per step 3.2 in the operating procedure, turn the dial on the film controls until "Film 9" is displayed.
4. Press the "next" button.
5. Rotate the dial to set the density to the appropriate value.
6. Use the "next" and "previous" buttons to cycle through density, tooling factor, z-ratio, and desired final thickness. If you make a mistake, press the "clear" button.
7. Press the "program" button when done to save your settings. Proceed to step 4 of the operating procedures.

Deposition material properties:

Formula	Density	Z-Ratio	Acoustic Impedance	Material Name
Ag	10.5	0.529	16.69	Silver
AgBr	6.47	1.18	7.48	Silver Bromide
AgCl	5.56	1.32	6.69	Silver Chloride
Al	2.70	1.08	8.18	Aluminum
Al2O3	3.97	0.336	26.28	Aluminum Oxide
Al4C3	2.36	?		Aluminum Carbide
AlF3	3.07	?		Aluminum Fluoride
AlN	3.26	?		Aluminum Nitride
AlSb	4.36	0.743	11.88	Aluminum Antimonide
As	5.73	0.966	9.14	Arsenic
As2Se3	4.75	?		Arsenic Selenide
Au	19.3	0.381	23.18	Gold
B	2.37	0.389	22.70	Boron
B2O3	1.82	?		Boron Oxide
B4C	2.37	?		Boron Carbide
BN	1.86	?		Boron Nitride
Ba	3.5	2.1	4.20	Barium
BaF2	4.886	0.793	11.13	Barium Fluoride
BaN2O6	3.244	1.261	7.00	Barium Nitrate
BaO	5.72	?		Barium Oxide
BaTiO3	5.999	0.464	19.03	Barium Titanate (Tetr)
BaTiO3	6.035	0.412	21.43	Barium Titanate (Cubic)
Be	1.85	0.543	16.26	Beryllium
BeF2	1.99	?		Beryllium Fluoride
BeO	3.01	?		Beryllium Oxide
Bi	9.8	0.79	11.18	Bismuth
Bi2O3	8.9	?		Bismuth Oxide
Bi2S3	7.39	?		Bismuth Trisuiphide
Bi2Se3	6.82	?		Bismuth Selenide
Bi2Te3	7.7	?		Bismuth Telluride
BiF3	5.32	?		Bismuth Fluoride
C	2.25	3.26	2.71	Carbon (Graphite)
C	3.52	0.22	40.14	Carbon (Diamond)
C8H8	1.1	?		Parlyene (Union Carbide)
Ca	1.55	2.62	3.37	Calcium
CaF2	3.18	0.775	11.39	Calcium Fluoride
CaO	3.35	?		Calcium Oxide
CaO-SiO2	2.9	?		Calcium Silicate (3)

Formula	Density	Z-Ratio	Acoustic Impedance	Material Name
CaSO4	2.962	0.955	9.25	Calcium Sulfate
CaTiO3	4.1	?		Calcium Titanate
CaWO4	6.06	?		Calcium Tungstate
Cd	8.64	0.682	12.95	Cadmium
CdF2	6.64	?		Cadmium Fluoride
CdO	8.15	?		Cadmium Oxide
CdS	4.83	1.02	8.66	Cadmium Sulfide
CdSe	5.81	?		Cadmium Selenide,
CdTe	6.2	0.98	9.01	Cadmium Telluride
Ce	6.78	?		Cerium
CeF3	6.16	?		Cerium (III) Fluoride
CeO2	7.13	?		Cerium (IV) Dioxide
Co	8.9	0.343	25.74	Cobalt
CoO	6.44	0.412	21.43	Cobalt Oxide
Cr	7.2	0.305	28.95	Chromium
Cr2O3	5.21	?		Chromium (III) Oxide
Cr3C2	6.68	?		Chromium Carbide
CrB	6.17	?		Chromium Boride
Cs	1.87	?		Cesium
Cs2SO4	4.243	1.212	7.29	Cesium Sulfate
CsBr	4.456	1.41	6.26	Cesium Bromide
CsCl	3.988	1.399	6.31	Cesium Chloride
CsI	4.516	1.542	5.73	Cesium Iodide
Cu	8.93	0.437	20.21	Copper
Cu2O	6	?		Copper Oxide
Cu2S	Cu2S	5.6	1.58	Copper (I) Sulfide (Alpha)
Cu2S	Cu2S	5.8	1.52	Copper (I) Sulfide (Beta)
CuS	CuS	4.6	1.92	Copper (II) Sulfide
Dy	Dy	8.55	1.03	Dysprosium
Dy2O3	Dy2O3	7.81	1.13	Dysprosium Oxide
Er	Er	9.05	0.98	Erbium
Er2O3	Er2O3	8.64	1.02	Erbium Oxide
Eu	Eu	5.26	1.68	Europium
EuF2	EuF2	6.5	1.36	Europium Fluoride
Fe	7.86	0.349	25.30	Iron
Fe2O3	5.24	?		Iron Oxide
FeO	5.7	?		Iron Oxide
FeS	4.84	?		Iron Sulphide
Ga	5.93	0.593	14.89	Gallium
Ga2O3	5.88	?		Gallium Oxide (B)

Formula	Density	Z-Ratio	Acoustic Impedance	Material Name
GaAs	5.31	1.59	5.55	Gallium Arsenide
GaN	6.1	?		Gallium Nitride
GaP	4.1	?		Gallium Phosphide
GaSb	5.6	?		Gallium Antimonide
Gd	7.89	0.67	13.18	Gadolinium
Gd2O3	7.41	?		Gadolinium Oxide
Ge	5.35	0.516	17.11	Germanium
Ge3N2	5.2	?		Germanium Nitride
GeO2	6.24	?		Germanium Oxide
GeTe	6.2	?		Germanium Telluride
Hf	13.09	0.36	24.53	Hafnium
HfB2	10.5	?		Hafnium Boride,
HfC	12.2	?		Hafnium Carbide
HfN	13.8	?		Hafnium Nitride
HfO2	9.68	?		Hafnium Oxide
HfSi2	7.2	?		Hafnium Silicide
Hg	13.46	0.74	11.93	Mercury
Ho	8.8	0.58	15.22	Holminum
Ho2O3	8.41	?		Holminum Oxide
In	7.3	0.841	10.50	Indium
In2O3	7.18	?		Indium Sesquioxide
In2Se3	5.7	?		Indium Selenide
In2Te3	5.8	?		Indium Telluride
InAs	5.7	?		Indium Arsenide
InP	4.8	?		Indium Phosphide
InSb	5.76	0.769	11.48	Indium Antimonide
Ir	22.4	0.129	68.45	Iridium
K	0.86	10.189	0.87	Potassium
KBr	2.75	1.893	4.66	Potassium Bromide
KCl	1.98	2.05	4.31	Potassium Chloride
KF	2.48	?		Potassium Fluoride
KI	3.128	2.077	4.25	Potassium Iodide
La	6.17	0.92	9.60	Lanthanum
La2O3	6.51	?		Lanthanum Oxide
LaB6	2.61	?		Lanthanum Boride
LaF3	5.94	?		Lanthanum Fluoride
Li	0.53	5.9	1.50	Lithium
LiBr	3.47	1.23	7.18	Lithium Bromide
LiF	2.638	0.778	11.35	Lithium Fluoride
LiNbO3	4.7	0.463	19.07	Lithium Niobate

Formula	Density	Z-Ratio	Acoustic Impedance	Material Name
Lu	9.84	?		Lutetium
Mg	1.74	1.61	5.48	Magnesium
MgAl2O4	3.6	?		Magnesium Aluminate
MgAl2O6	8	?		Spinel
MgF2	3.18	0.637	13.86	Magnesium Fluoride
MgO	3.58	0.411	21.48	Magnesium Oxide
Mn	7.2	0.377	23.42	Manganese
MnO	5.39	0.467	18.91	Manganese Oxide
MnS	3.99	0.94	9.39	Manganese (II) Sulfide
Mo	10.2	0.257	34.36	Molybdenum
Mo2C	9.18	?		Molybdenum Carbide
MoB2	7.12	?		Molybdenum Boride
MoO3	4.7	?		Molybdenum Trioxdide
MoS2	4.8	?		Molybdenum Disulfide
Na	0.97	4.8	1.84	Sodium
Na3AlF6	2.9	?		Cryolite
Na5AL3F14	2.9	?		Chiolite
NaBr	3.2	?		Sodium Bromide
NaCl	2.17	1.57	5.62	Sodium Chloride
NaClO3	2.164	1.565	5.64	Sodium Chlorate
NaF	2.558	0.949	9.30	Sodium Fluoride
NaNO3	2.27	1.194	7.40	Sodium Nitrate
Nb	8.578	0.492	17.95	Niobium (Columbium)
Nb2O3	7.5	?		Niobium Trioxide
Nb2O5	4.47	?		Niobium (V) Oxide
NbB2	6.97	?		Niobium Boride
NbC	7.82	?		Niobium Carbide
NbN	8.4	?		Niobium Nitride
Nd	7	?		Neodynium
Nd2O3	7.24	?		Neodynium Oxide
NdF3	6.506	?		Neodynium Fluoride
Ni	8.91	0.331	26.68	Nickel
NiCr	8.5	?		Nichrome
NiCrFe	8.5	?		Inconel
NiFe	8.7	?		Permalloy
NiFeMo	8.9	?		Supermalloy
NiO	7.45	?		Nickel Oxide
P3N5	2.51	?		Phosphorus Nitride
Pb	11.3	1.13	7.81	Lead
PbCl2	5.85	?		Lead Chloride

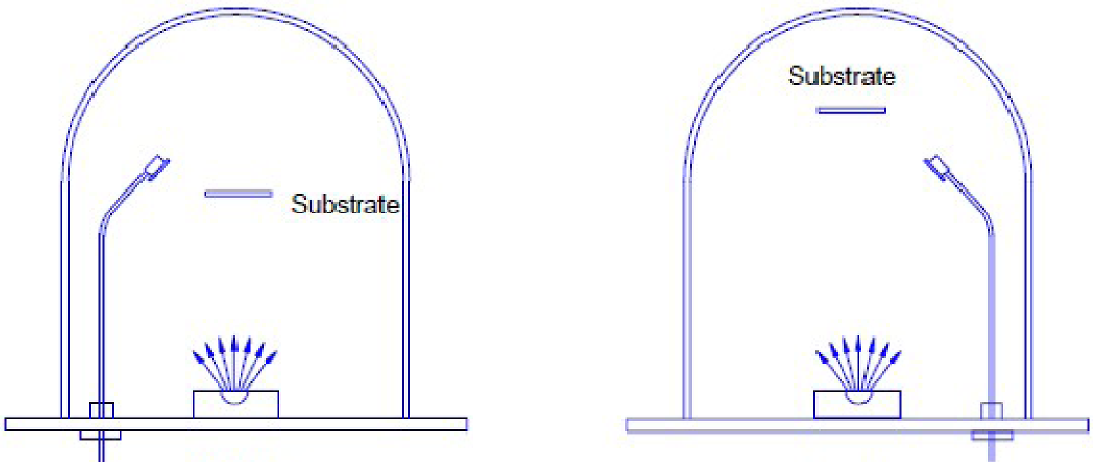
Formula	Density	Z-Ratio	Acoustic Impedance	Material Name
PbF2	8.24	0.661	13.36	Lead Fluoride
PbO	9.53	?		Lead Oxide
PbS	7.5	0.566	15.60	Lead Sulfide
PbSe	8.1	?		Lead Selenide
PbSnO3	8.1	?		Lead Stannate
PbTe	8.16	0.651	13.56	Lead Telluride
Pd	12.038	0.357	24.73	Palladium
PdO	8.31	?		Palladium Oxide
Po	9.4	?		Polonium
Pr	6.78	?		Praseodymium
Pr2O3	6.88	?		Praseodymium Oxide
Pt	21.4	0.245	36.04	Platinum
PtO2	10.2	?		Platinum Oxide
Ra	5	?		Radium
Rb	1.53	2.54	3.48	Rubidium
RbI	3.55	?		Rubidium Iodide
Re	21.04	0.15	58.87	Rhenium
Rh	12.41	0.21	42.05	Rhodium
Ru	12.362	0.182	48.52	Ruthenium
S8	2.07	2.29	3.86	Sulphur
Sb	6.62	0.768	11.50	Antimony
Sb2O3	5.2	?		Antimony Trioxide
Sb2S3	4.64	?		Antimony Trisulfide
Sc	3	0.91	9.70	Scandium
Sc2O3	3.86	?		Scandium Oxide
Se	4.81	0.864	10.22	Selenium
Si	2.32	0.712	12.40	Silicon
Si3N4	3.44	*1000		Silicon Nitride
SiC	3.22	?		Silicon Carbide
SiO	2.13	0.87	10.15	Silicon (II) Oxide
SiO2	2.648	1	8.83	Silicon Dioxide
Sm	7.54	0.89	9.92	Samarium
Sm2O3	7.43	?		Samarium Oxide
Sn	7.3	0.724	12.20	Tin
SnO2	6.95	?		Tin Oxide
SnS	5.08	?		Tin Sulfide
SnSe	6.18	?		Tin Selenide
SnTe	6.44	?		Tin Telluride
Sr	2.6	?		Strontium
SrF2	4.277	0.727	12.15	Strontium Fluroide

Formula	Density	Z-Ratio	Acoustic Impedance	Material Name
SrO	4.99	0.517	17.08	Strontium Oxide
Ta	16.6	0.262	33.70	Tantalum
Ta2O5	8.2	0.3	29.43	Tantalum (V) Oxide
TaB2	11.15	?		Tantalum Boride
TaC	13.9	?		Tantalum Carbide
TaN	16.3	?		Tantalum Nitride
Tb	8.27	0.66	13.38	Terbium
Tc	11.5	?		Technetium
Te	6.25	0.9	9.81	Tellurium
TeO2	5.99	0.862	10.24	Tellurium Oxide
Th	11.694	0.484	18.24	Thorium
ThF4	6.32	?		Thorium (IV) Fluoride
ThO2	9.86	0.284	31.09	Thorium Dioxide
ThOF2	9.1	?		Thorium Oxyfluoride
Ti	4.5	0.628	14.06	Titanium
Ti2O3	4.6	?		Titanium Sesquioxide
TiB2	4.5	?		Titanium Boride
TiC	4.93	?		Titanium Carbide
TiN	5.43	?		Titanium Nitride
TiO	4.9	?		Titanium Oxide
TiO2	4.26	0.4	22.08	Titanium (IV) Oxide
Tl	11.85	1.55	5.70	Thallium
TlBr	7.56	?		Thallium Bromide
TlCl	7	?		Thallium Chloride
TlI	7.09	?		Thallium Iodide (B)
U	19.05	0.238	37.10	Uranium
U3O8	8.3	?		Tri Uranium Octoxide
U4O9	10.969	0.348	25.37	Uranium Oxide
UO2	10.97	0.286	30.87	Uranium Dioxide
V	5.96	0.53	16.66	Vanadium
V2O5	3.36	?		Vanadium Pentoxide
VB2	5.1	?		Vanadium Boride
VC	5.77	?		Vanadium Carbide
VN	6.13	?		Vanadium Nitride
VO2	4.34	?		Vanadium Dioxide
W	19.3	0.163	54.17	Tungsten
WB2	10.77	?		Tungsten Boride
WC	15.6	0.151	58.48	Tungsten Carbide
WO3	7.16	?		Tungsten Trioxide
WS2	7.5	?		Tungsten Disulphide

Formula	Density	Z-Ratio	Acoustic Impedance	Material Name
WSi2	9.4	?		Tungsten Suicide
Y	4.34	0.835	10.57	Yttrium
Y2O3	5.01	?		Yttrium Oxide
Yb	6.98	1.13	7.81	Ytterbium
Yb2O3	9.17	?		Ytterbium Oxide
Zn	7.04	0.514	17.18	Zinc
Zn3Sb2	6.3	?		Zinc Antimonide
ZnF2	4.95	?		Zinc Fluoride
ZnO	5.61	0.556	15.88	Zinc Oxide
ZnS	4.09	0.775	11.39	Zinc Sulfide
ZnSe	5.26	0.722	12.23	Zinc Selenide
ZnTe	6.34	0.77	11.47	Zinc Telluride
Zr	6.49	0.6	14.72	Zirconium
ZrB2	6.08	?		Zirconium Boride
ZrC	6.73	0.264	33.45	Zirconium Carbide
ZrN	7.09	?		Zirconium Nitride
ZrO2	5.6	?		Zirconium Oxide

Appendix B: Tooling Factor (optional)

How do I determine Tooling Factor?
Tooling Factor adjusts for the difference in material deposited on the quartz sensor versus the substrate. This is an inherent problem. We don't want to cover your sample with the detector! Tooling may be less than or greater than 100% as shown below.



Tooling
Over 100%

Tooling
Under 100%

1. Place your substrate and a new quartz sensor in their normal position.
2. Set Tooling to an approximate value; Set Density and Z-Factor for your material.
3. Deposit approximately 1000 to 2500 Å of material.
4. Use a profilometer to measure the substrate's film thickness.
5. The correct Tooling Factor is calculated by:

$$\text{Tooling}_{\text{ACTUAL}} = \text{Tooling}_{\text{APPROX}} \times \frac{\text{Thickness}_{\text{ACTUAL}}}{\text{Thickness}_{\text{QCM}}}$$

Why do I determine Tooling Factor?
It is necessary for very accurate deposition.