Summary Of Plan For 8-Inch Photocathode For The Single-Tile Factory

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The starting point of the plan for photocathode fabrication for the single-tile factory is the bialkali photocathode recipe that we acquired from Photonis USA. There are several important aspects to this recipe that will be duplicated for the 8-inch photocathode production:

1. *In situ* O_2 dosing

   The ability to perform *in situ* O2 dosing onto the surface of the glass substrate allows for (i) less stringent cleaning process on the substrate and (ii) the formation of oxide layer that enhances absorption in the long wavelength.

2. Glass enclosure

   Heating the glass enclosure creates a vapor pressure of the alkali metal being evaporated inside the vessel. This eliminates line-of-sight evaporation and produces a more uniform alkali metal deposition.

3. Sb reflectivity

   The use of reflectivity measurement to monitor the Sb thickness.

We have successfully produced KCsSb photocathode inside PMTs using the Burle equipment, with quantum efficiencies in the low 20%. We are currently making progress in producing 4"x4: photocathodes inside a larger glass vessel (the "chalice"). The intention here is to adapt the knowledge that we have acquired from both techniques to the 8" photocathode growth in the single-tile factory.

The current plan for the 8" photocathode fabrication is as follows:

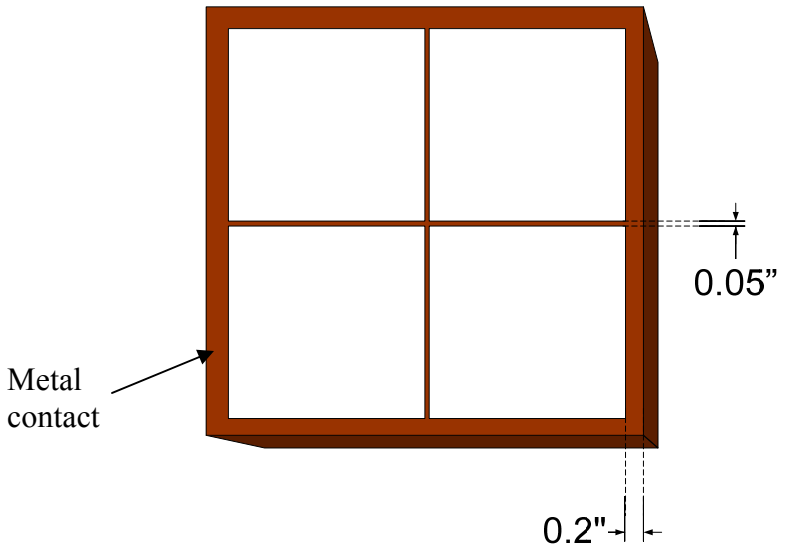
1. Cleaning glass plate using standard ultra-high vacuum cleaning requirement (citronox/liquinox and acetone/alcohol);
2. Deposition of metallic contacts;
3. Repeat cleaning if necessary;
4. Mount plate in vacuum chamber, bake, and perform O_2 dosing;
5. Evaporate initial Sb layer, monitoring the thickness via reflectivity measurement;
6. Perform O_2 dosing once again to create the oxide layer;
7. Evaporate final Sb layer, monitoring the thickness as before;
8. Heat glass enclosure/vessel inside the vacuum chamber to 160 C.
9. Begin alkali metals deposition, monitoring the photocurrent concurrently;

10. Cool down glass plate, and transfer to the next part of the tile assembly process.

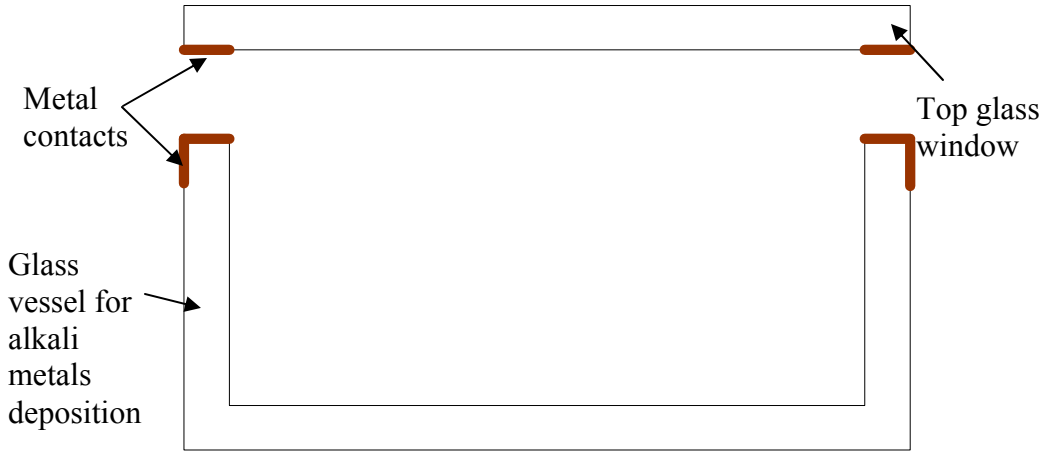
This series of process will require optimization. Steps 4 and 6 may be performed in a dedicated chamber for O_2 dosing only, while Steps 8 and 9 must be done in a glass enclosure. Because of the separate requirements, Steps 4, 5, 6, and 7 may be performed in one chamber, while Steps 8 and 9 done in another chamber. The exact design will depend on solving the engineering issues.

Placement of the evaporative sources has to be worked out. This is more of a factor for Sb deposition, which uses line-of-sight. A simulation will be done, similar to the one performed for the 4”x4” photocathode, to determine the most optimum positions for the Sb beads. The positions of the alkali metal sources are less crucial once they are confined within a glass vessel. If the vessel can be heated to 160 C, the vapor pressure for each of the alkali metal can be maintained, and a uniform growth of the photocathode on the Sb film should commence.

Proper electrical contact to the glass plate is crucial. The photocathode must be grounded during the alkali metals deposition, when the photocurrent is monitored. The glass plate will have electrical contacts (Al or other metals to be determined) similar to the one shown below:



The width of the outside border is equal to the thickness of the side wall of the tile. If the glass vessel for alkali metal deposition has the same metallic coating as shown below, one can make a good electrical contact to the glass plate when it is resting on the vessel. Note that the entire vessel is inside a UHV chamber. Various “plumbing” and innards are not shown.



Details on the optics to monitor the reflectivity during Sb deposition, and to monitor the photocurrent during the alkali metals deposition, have to be worked out. It may be "easier" to monitor the transmission during the Sb deposition instead of the reflection.