

Rejuvenation of a Depreciated Photocathode

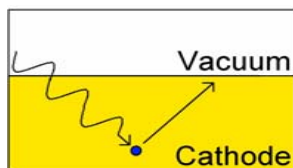
Jessica Leung, Eric J. Montgomery, Zhigang Pan, Patrick G. O'Shea

Motivation

The rejuvenation of photocathodes would improve high-quality electron beams.

Background

Photoelectric Effect: An electron absorbs laser photon energy, escapes from the material, and is emitted into the vacuum.



Quantum Efficiency (QE) =

$$\frac{\# \text{ electrons}}{\# \text{ photons}}$$

$$QE (\%) = \frac{i \text{ (A)}}{P_{\text{laser}} \text{ (W)}} \cdot \frac{(124)}{\lambda \text{ (\mu m)}}$$

Present Goals

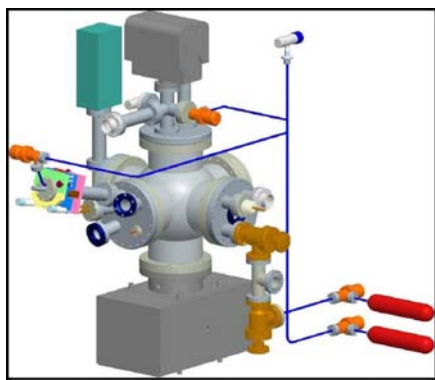
- 1) Find the minimum cleaning time for Ag:Cs photocathodes.
- 2) Calculate sputtering efficiency.
- 3) Show that QE can be rejuvenated after contamination in preparation for Cs dispenser cathodes.

Long-Term Goal

Create photocathodes with high QE and long lifetimes.

Techniques

- 1) A **High-Vacuum Chamber** houses the cathode and prevents atmospheric contamination.
 - Roughing pump: ~1 Torr
 - Turbo pump: ~1 x 10⁻⁷ Torr
 - Ion pump: ~ 1 x 10⁻¹⁰ Torr



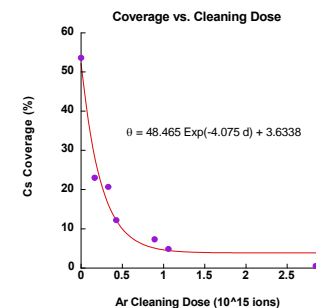
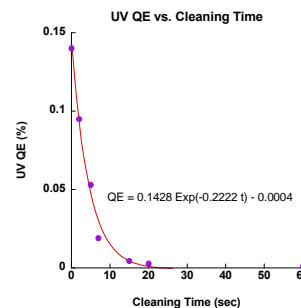
- 2) **Argon Ion Bombardment** atomically cleans the surface of the photocathode.
- 3) **Cesium Deposition** from an external evaporative source covers the cathode, increasing QE. Amount deposited is measured with a quartz crystal monitor.

Experiments

- 1) **Ion Cleaning/Sputtering Efficiency:**
 - a) Begin with a clean silver surface.
 - b) Deposit Cs to peak QE.
 - c) Timed ion-clean.
 - d) Measure QE using LabVIEW.
- 2) **Controlled Gas Contamination:**
 - a) Begin with a clean cesiated surface.
 - b) Expose to gas, depleting QE.
 - c) Recesiate the surface.
 - d) Observe any rejuvenation of QE.

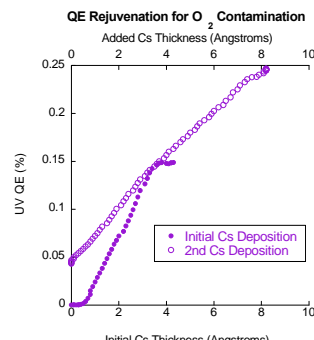
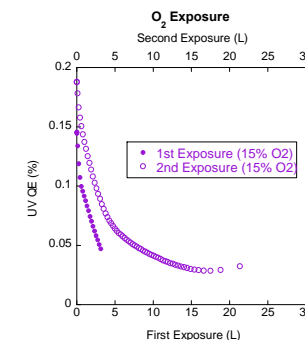
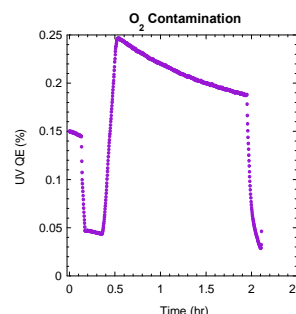
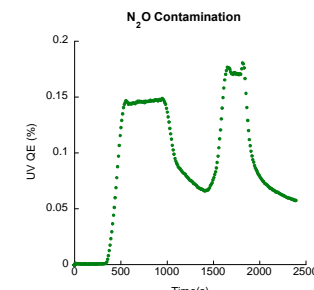
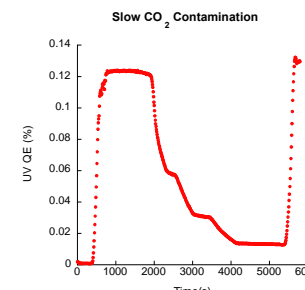
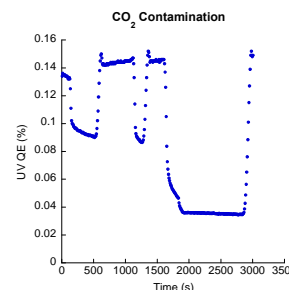
Ion Cleaning Results

UV $\lambda = 375 \text{ nm}$



- 1) The **minimum** cleaning time was **20 seconds** at 1.5 mA of Ar ion current.
- 2) **Sputtering Efficiency:** About **3 atoms** of Cs were knocked off with each Ar-ion accelerated during cleaning. This compares well with literature values.

Controlled Contamination Results



Conclusion

A depreciated QE can be rejuvenated by recession!

Future Work

- 1) Contamination studies with high QE materials.
- 2) Studies of surface interactions.