Photocathodes at the University of Maryland

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Photocathodes

Photoelectric effect
http://commons.wikimedia.org

Quantum Efficiency (QE) = \frac{\# \text{ electrons emitted}}{\# \text{ photons incident}}
Photocathode Efficiency vs. Lifetime

EJ Montgomery, PhD thesis 2010

Time constant of initial QE decay (hours to 1/e at 1 nTorr)

Quantum Efficiency (%)
Multi-wavelength QE measurement

Multi-alkali cathode fabrication
QE Circuit

[Diagram of a QE circuit with labels: 0-30 kV/m, 1.5 cm, Keithley 486, 0-450 V, nA, 10 kΩ, triax cable]
Cesium

Cs:W deposition (100 °C)

Cs:W evaporation
Cesium Rejuvenation

Chromate free, clean release
Activation ~300 °C
CO$_2$ Rejuvenation test

1. Initial QE: Cs on clean substrate
2. Exposure to gas begins; QE depreciates
3. Gas exposure stops
4. Recesiation begins
5. Recesiation ends: note full rejuvenation of QE

Cs:Ag
More Tests

CO₂

O₂

N₂O

Cs:Ag
Mass Flow Rate
Mass Flow Rate (1 pore)

\[ Q \sim \frac{D^3}{L} \]

<table>
<thead>
<tr>
<th>D</th>
<th>Pore size (i.e. radius)</th>
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<tbody>
<tr>
<td>L</td>
<td>Pore length</td>
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Mass Flow Rate

**Wire Diameter: 20 to 8 microns**

\[ Q_{\text{total}} \sim Q_{\text{pore}} N_{\text{pore}} \]

<table>
<thead>
<tr>
<th>Constant number of pores</th>
<th>( Q_{\text{total}} \sim \frac{D^3}{L} )</th>
<th>Q decreases by 94%</th>
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<tbody>
<tr>
<td>Constant cathode area</td>
<td>( Q_{\text{total}} \sim \frac{D}{L} )</td>
<td>Q decreases by 60%</td>
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Summary & Outlook

• About a half monolayer of Cs increases QE
• Cs dispenser design prolongs lifetime
• Need to control Cs flow rate before tests in other systems
• Test new photocathodes