Characterization of Cesium-based Photocathodes for Free Electron Lasers

Saara A. Khan, Eric J. Montgomery, Patrick O'Shea, Blake Riddick

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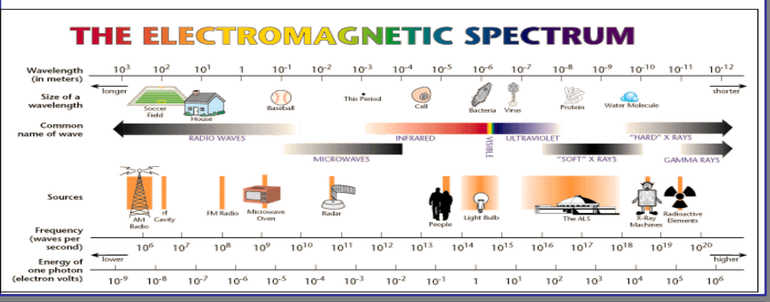
Introduction

•Free Electron Lasers create light where there is darkness.

•Examples: X-Ray, UV, IR (THz freq.)



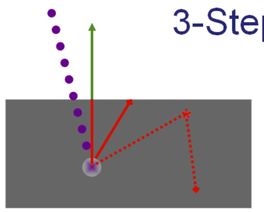
Photocathodes

•Photocathodes are used in Free Electron Lasers to produce bright, laser-switched electron beams

•When struck by light, photocathodes release electrons (photoelectric effect)

•Shortcomings of photocathodes lie in maintaining lifetime and high QE

$$QE = \frac{\#\ electrons\ emitted}{\#\ photons\ incident}$$



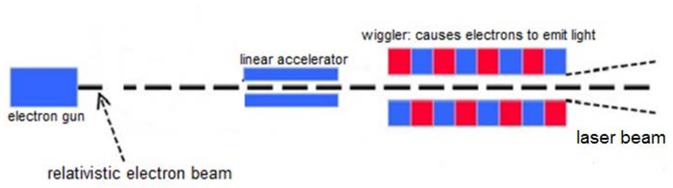
3-Step Model

1. Photon Absorption
2. Electron Transport
3. Electron Escape

Free Electron Lasers

•Free Electron Lasers are tunable light sources that can reach high average power

•Application of FELs: Navy Missile Defense



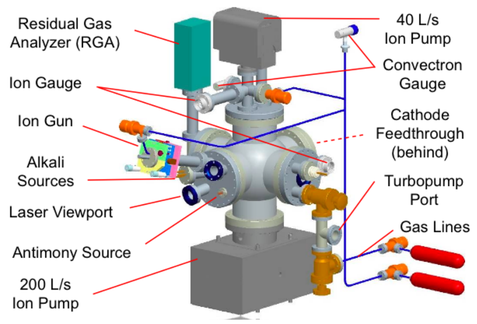
Overview

•Gold was evaporated onto a tungsten cathode and QE was measured as a function of amount of cesium applied

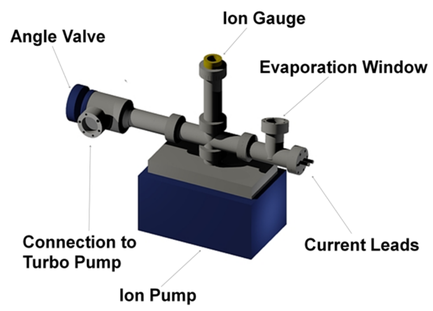
Experimental Apparatus

•Designed and built an evaporative chamber to deposit gold onto a dispenser-type substrate (porous tungsten)

Experimental Testing Apparatus



Gold Evaporation Chamber

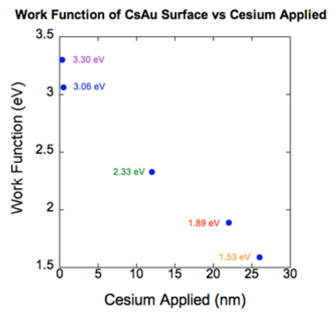


CsAu Intermetallic Alloy

•Deposition of cesium onto gold cathode resulted in CsAu intermetallic alloy at 300 K

•**Interdiffusion observed (unexpected from first deposition)**

•**Significant increase in QE seen**



Laser Wavelengths:

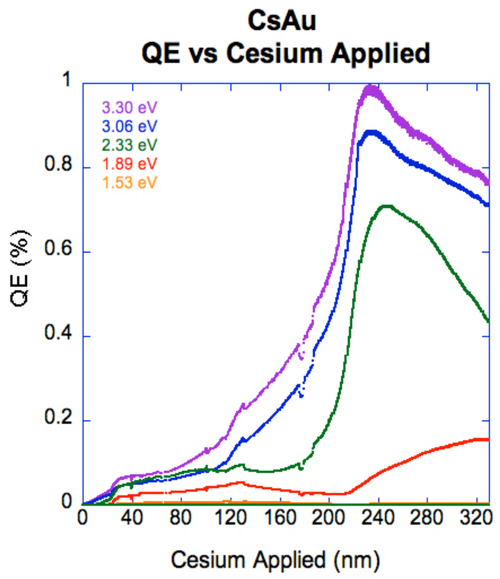
375 nm

405 nm

532 nm

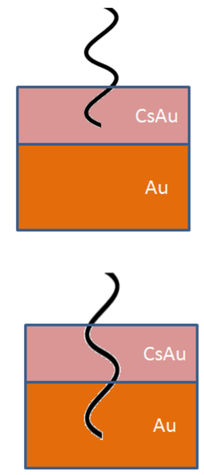
655 nm

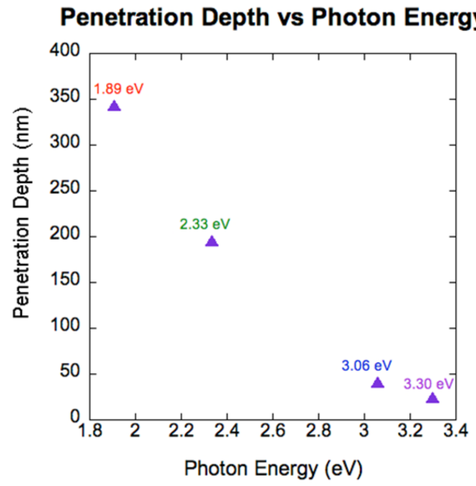
808 nm



Penetration Depth

•The penetration depth of each wavelength effects the time at which the peak QE occurs during cesium application.





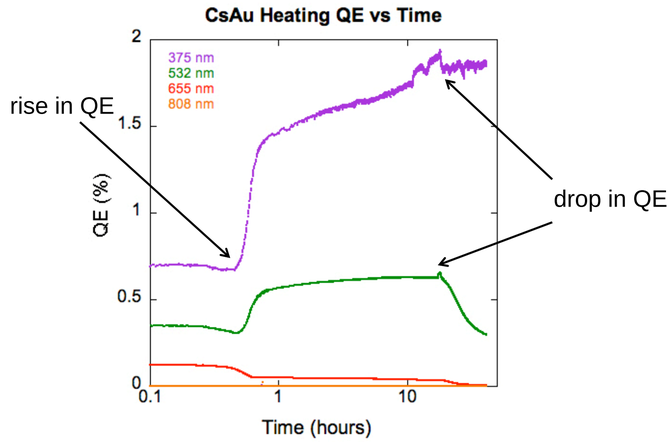
Spicer, W. E. Sommer, A. H. White, J. G., Physical Review 115(1), 1959

Heating CsAu

•QE improves

•Overcesiation presumed corrected

•More uniform stoichiometry



Future Work

•Contamination testing

  •Literature indicates high reaction with oxygen

•Analyze compatibility with cesium dispenser

  •Thermal stability below 150 C in question

  •Likely to lose Cs faster than supply rate of Cs