Progress Toward Immunization of III-V Photocathodes for Application to RF Gun Injectors

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Why Immunization?

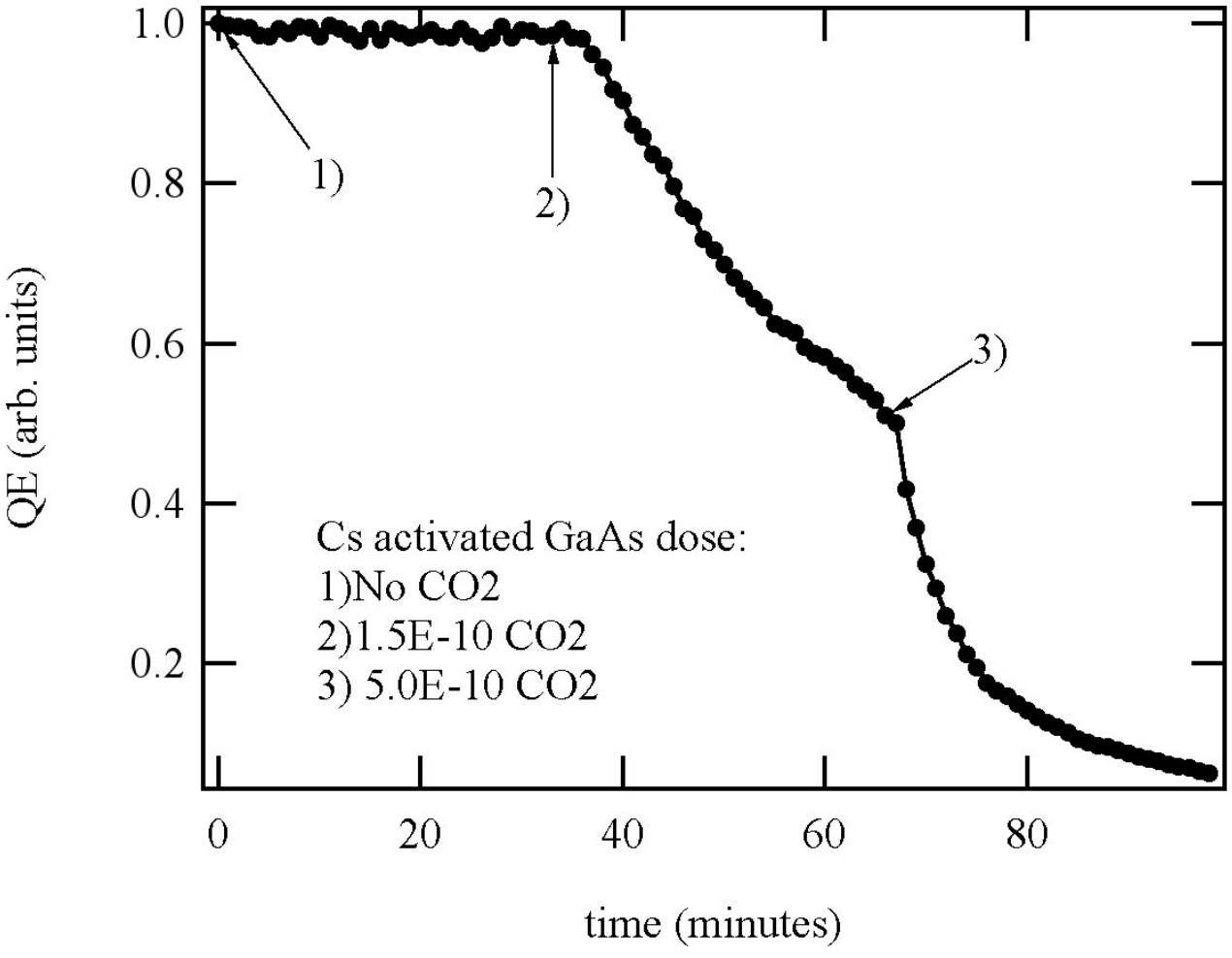
- Ideal emitter: Operates well in poor vacuum
- Reality: RF gun environment tough on photoemitters

- High average current operation – ion/electron damage

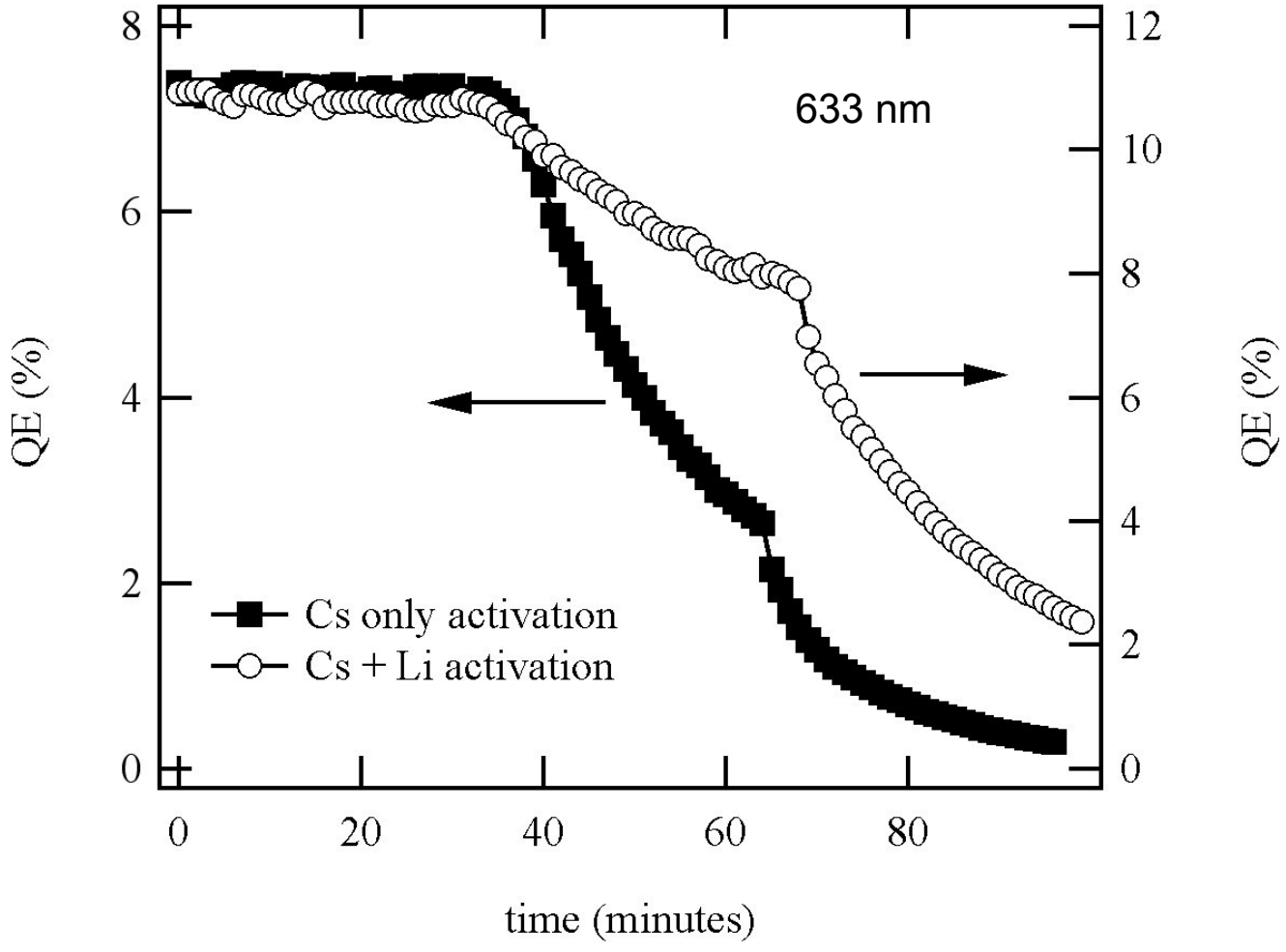
- High polarization emitters need UHV (XHV for some gases)

- Improved performance is always desired

CO_2 as the Archetypical "Bad" Gas (Saxet)



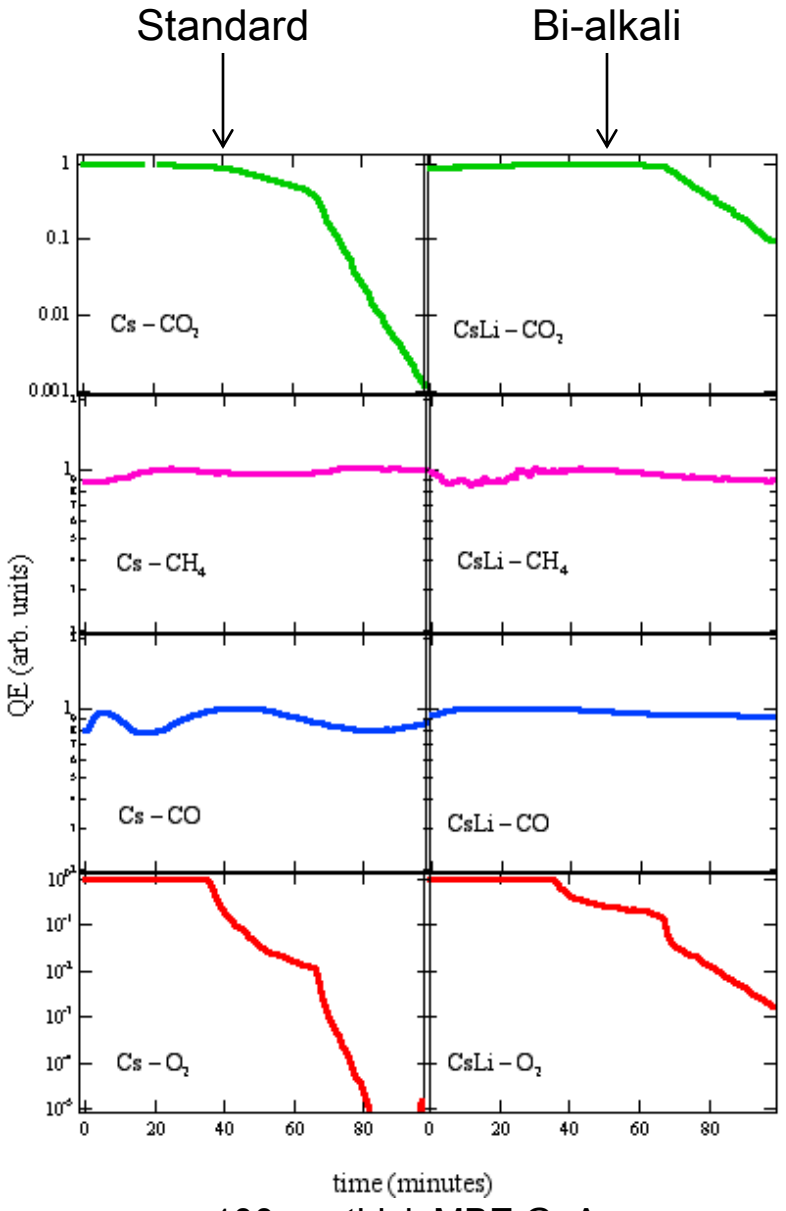
…Can be Immunized Against



Gas Sensitivity of Standard and Bi-Alkali Activated GaAs

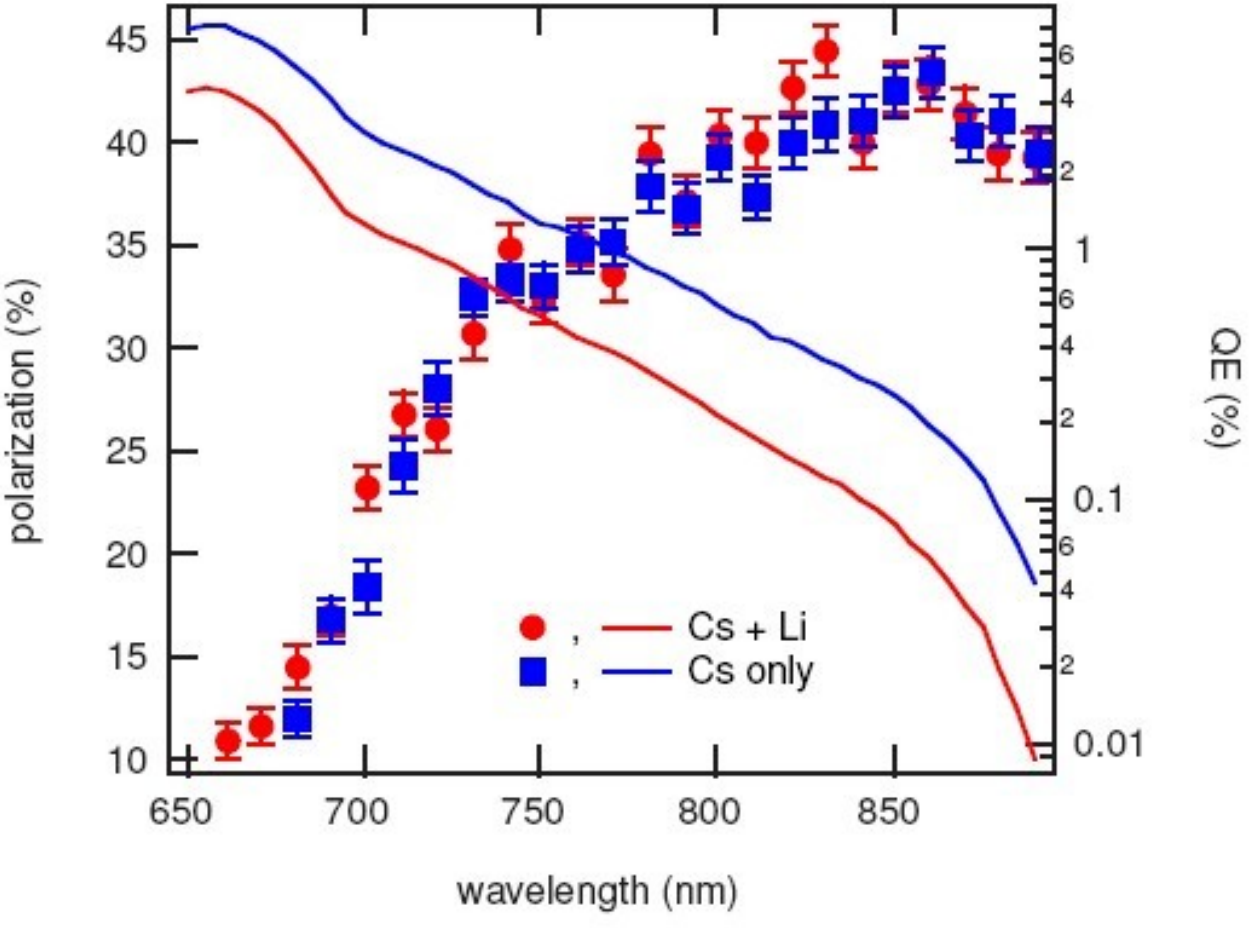
No discernible reactivity for CH_4 and CO for either type of activation.

<u>Much enhanced resistance</u> to CO_2 and O_2 exposure with the bi-alkali activation.



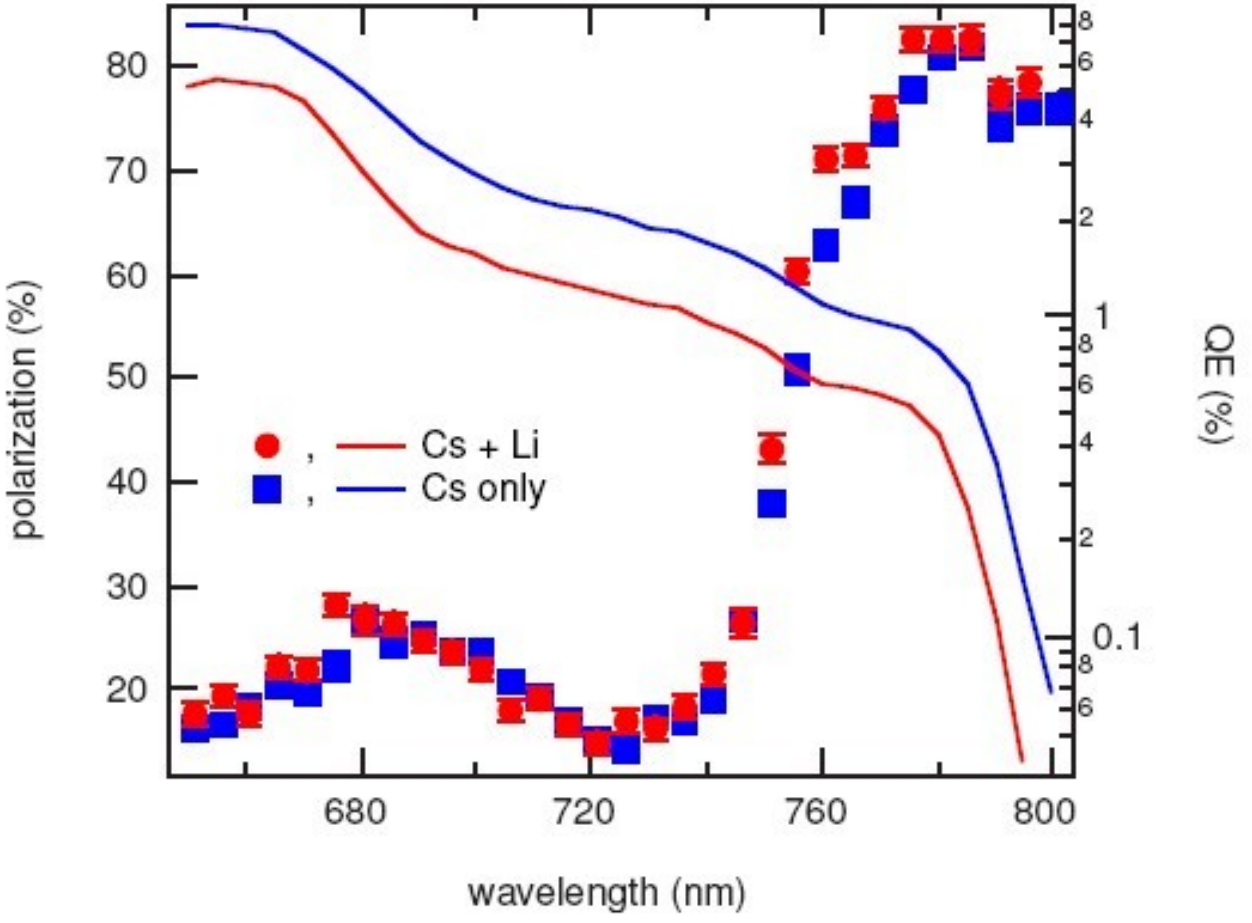
100 nm thick MBE GaAs

Yield and Polarization (SLAC)



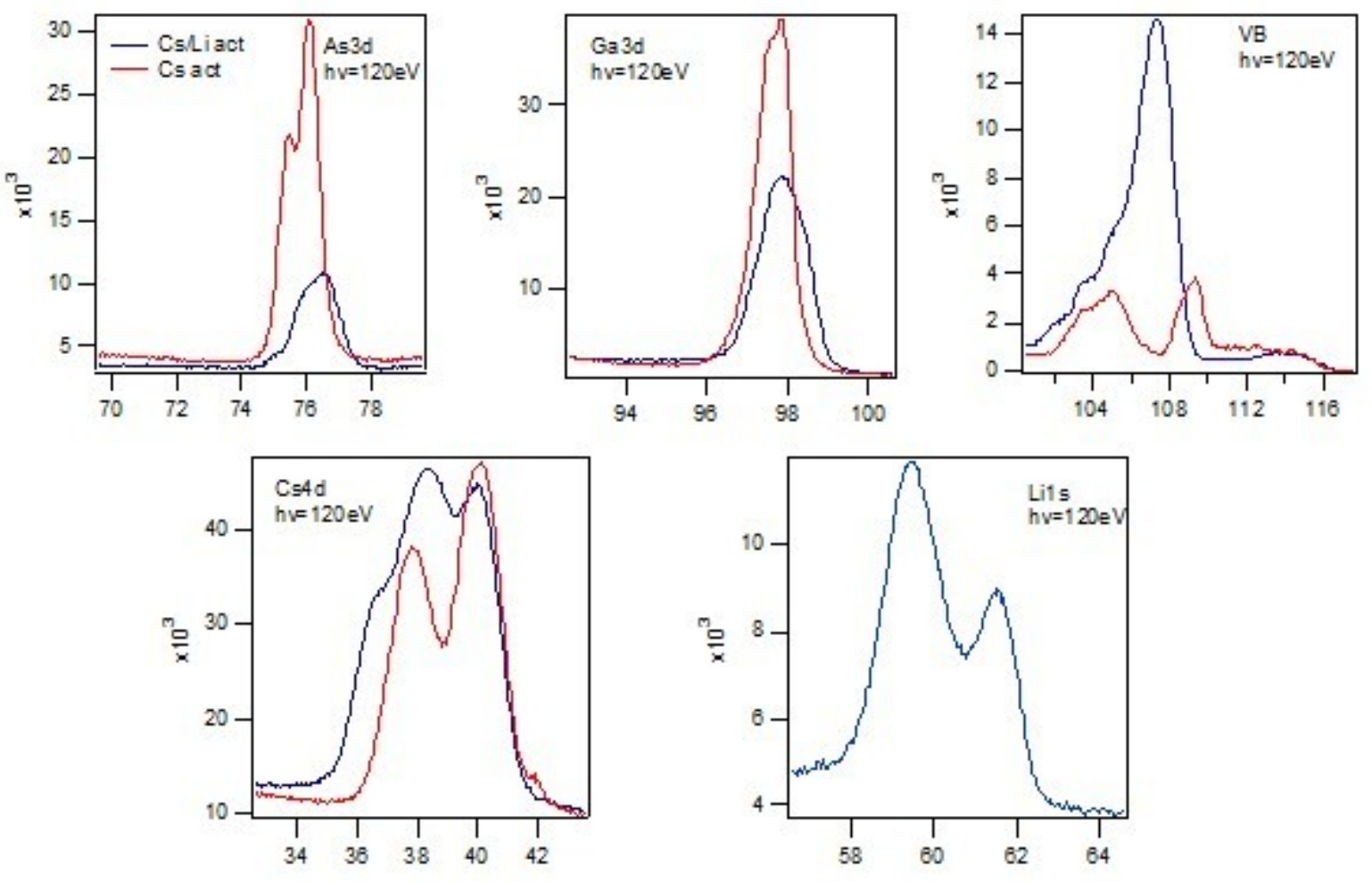
100 nm Unstrained GaAs

Yield and Polarization (SLAC)



GaAs/GaAsP Strained Superlattice

Surface Chemistry (SSRL)



Data Analysis in Progress But…

- Every variant of the dual activation process was tried, but only this one works.

- Li diffuses (by XPS) into the GaAs and does little charge transfer. Not a good dipole maker.

- More N and F in Cs/Li layer than in Cs-only layer and F is charge-shifted. Why, if the Li has diffused, out of dipole reach?

- XPS spectra very complex. This WILL be fun to unravel.

Future Plans

- Better understanding of the surface chemistry
- Complete analysis of the XPS data
  More experimental data is needed ($$)
- Ion-resistance tests of the bi-alkali activation layer
  New DOE SBIR starts July 2009
- Alternate photo-emitting layer: Amorphous silicon
  Second-year DOE SBIR July 2009

Amorphous Si, a Rather Odd Photo-Emitter

- Better than a metal
- Worse than a crystalline semiconductor, e.g., GaAs- due to strong defect scattering
- Grows on anything (e.g., RF gun backplane)
- VIS excitation
- Bandgap redshift by adding Ge
- Activates like GaAs, but must use Cs + O_2

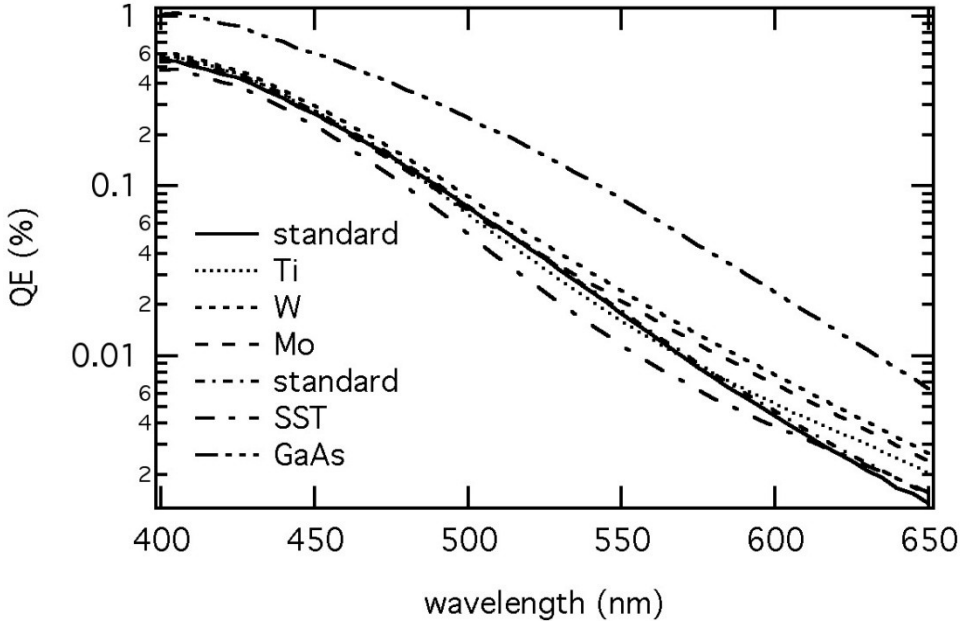


Photo-yield of a-Si On Various Substrates
(GaAs shows increase)