

Multi-alkali antimonides photocathodes for high-brightness RF photoinjectors

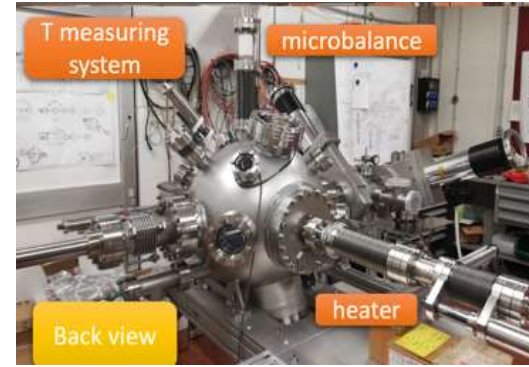
Sandeep Mohanty and Houjun Qian on behalf of PITZ & LASA team, MT ARD ST3 Meeting 2021,
30 th September 2021

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Cathode preparation

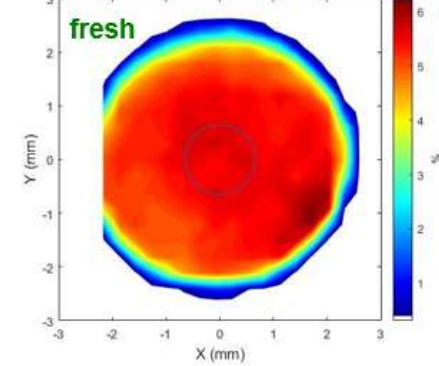
- Successfully produced the first batch of green cathode in “new production system” at INFN LASA.
 - ✓ Total 3 cathodes produced with sequential deposition.
 - ✓ Out of which 1 thick (147.1) (Sb= 10 nm) and 2 thin (112.1, 123.1) (Sb = 5 nm) cathodes..
 - ✓ Q.E @514 nm is recorded 4-8 % for thick and thin cathodes respectively after the production.
 - ✓ All the cathodes has been survived during the cathode box transportation, installation and cathode insertion.
- Due to unreliaint (broken) temperature measuring system, two cathodes (112.1 & 123.1) were grown relatively at lower temperature compare to cathode 147.1.
- Estimated the E_g+E_a value of grown cathode is around 1.8 eV, slightly lower than the literature value (2.1 eV). It is may due to the composition achieved is probably not stoichiometric.



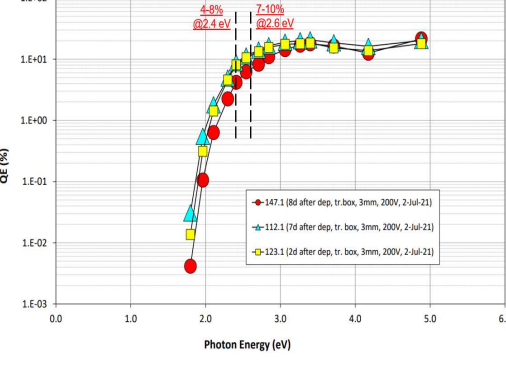
• New production system

• First batch of green cathode

Cathode#123.1; QE(BSA=1.3mm)=5.6% [20210712A]

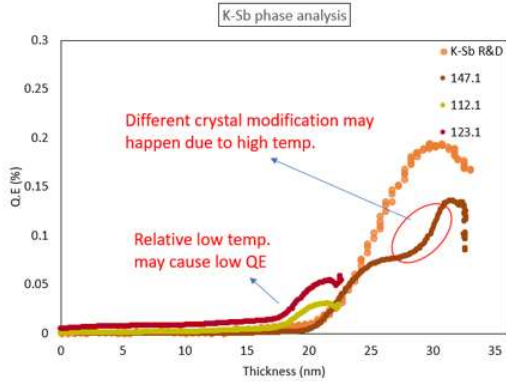


Before closing the suitcase UHV valve

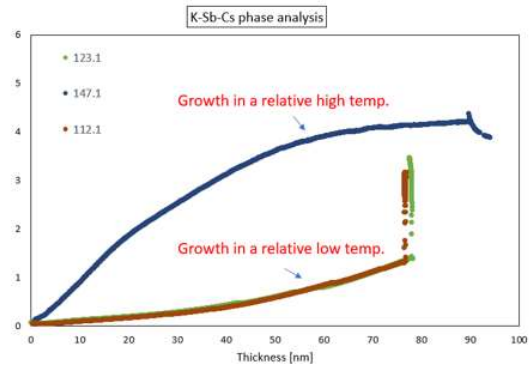


• Uniform QE

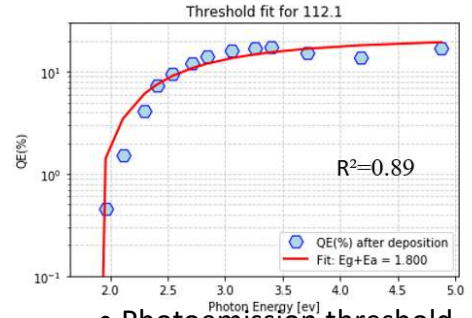
• Spectral response



• Growth history during K



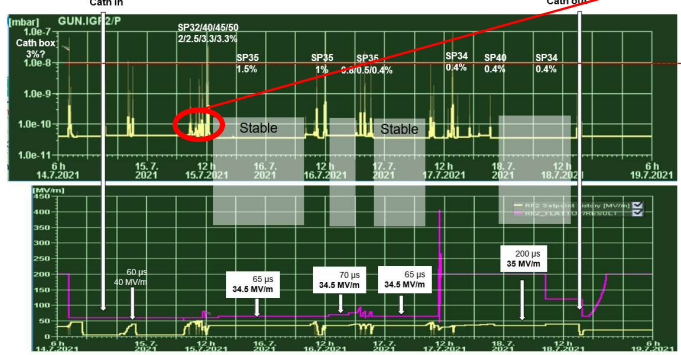
• Growth history during Cs



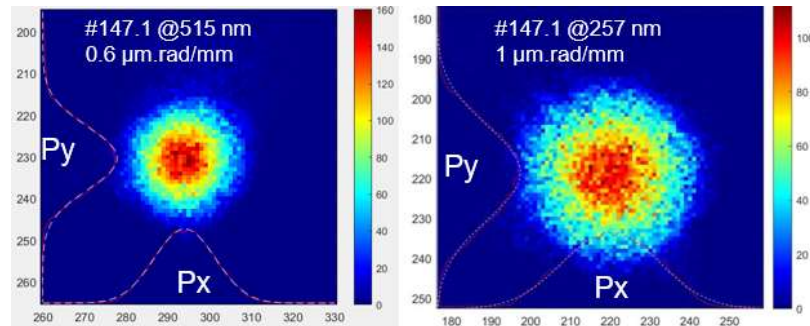
• Photoemission threshold

Test Results

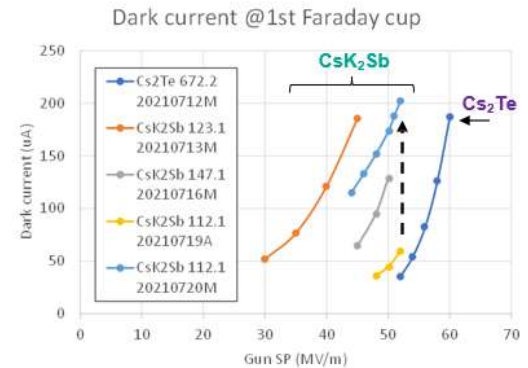
Operational history of cathode 147.1



Thermal emittance measurement



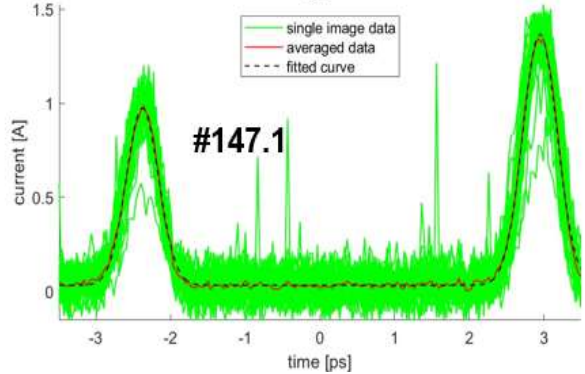
Dark Current



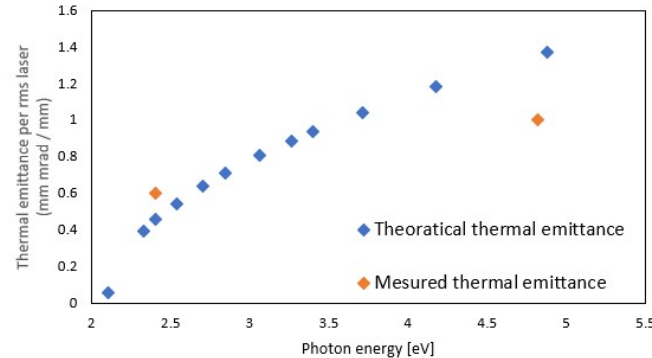
- Cathode conditioning
 - Below 30 MV/m, almost not necessary, up to 400 us was tested without vac events
 - Above 30-40 MV/m, much more vac events than Cs2Te conditioning, degrades QE significantly

Response time measurement

centered single and averaged bunch profiles, phase: -86



- One good dataset for #147.1, preliminary analysis shows ~50 fs, compared to ~200 fs of Cs2Te



- Thermal emittance
 - UV 4.8eV @19 MV/m, ~1 mm.mrad/mm (same as Cs2Te)
 - Green 2.4eV @19 MV/m, ~0.6 mm.mrad/mm
- Small deviation in green wavelength (may due to stoichiometry difference!) and a large deviation at high photon energy(may due to delayed emission).

- CsK2Sb cathodes has a higher dark current than the one from Cs2Te cathodes, which is due to the lower work function of CsK2Sb = 2.1 eV compared to Cs2Te = 3.5 eV.

■ Summary

- Total 3 cathodes produced with sequential deposition with QE @514 nm is recorded 4-8 %.
- All the cathodes has been survived during the cathode box transportation, installation and cathode insertion.
- Cathode conditioning
 - Below 30 MV/m, almost not necessary, up to 400 us was tested without vacuum events.
 - Above 30-40 MV/m, much more vac events than Cs₂Te conditioning, degrades QE significantly.
- QE drop within 2 days from 3-6% to below 1%, dominated by vacuum events during cathode conditioning, but there is also a slower QE decrease even without vacuum events (back ion bombardment, chemical contamination!!!).
- Thermal emittance
 - UV 4.8eV @19 MV/m, ~1 mm.mrad/mm (same Cs₂Te)
 - Green 2.4eV @19 MV/m, ~**0.6 mm.mrad/mm**
- CsKSb cathodes has a higher dark current than the one from Cs₂Te cathodes, which is due to the lower work function of CsKSb = 2.1 eV compared to Cs₂Te = 3.5 eV.
- Response time
 - One good dataset for #147.1, preliminary analysis shows ~**50 fs**, compared to ~200 fs of Cs₂Te