

Summary

**Siegfried Schreiber,
Giuseppe Penco, Antonella Loruzzo**

EUROFEL Workshop on Photocathodes
for RF guns

March 1-2, 2010
Lecce, Italy

Workhorses

- > Cs₂Te
 - Used at CTF/TTF/FLASH/A0/... and many other labs since many years
 - FLASH operates a user facility with Cs₂Te
- > GaAs
 - SLC/JLAB/... and man many other labs
- > Cu
 - LCLS/Fermi/... many more and to come
- > Mg



Metal Cathodes

> Metals

- Fast response: application for low rep.rate and femtosecond style beams
- high QE → decrease wavelength → increase of thermal emittance

> Prominent example: Cu and Mg

> Surface properties from for example X-ray diffraction analysis for Cu:

- surface has different crystal structure (111), (110), (100)
- with different work functions

> Lifetime Issue

- Lifetime ends, when with the given set-up (laser), the required charge cannot be delivered
- Example given for Cu:

QE drops within 30 days from $5 \cdot 10^{-5}$ to $1 \cdot 10^{-5}$



Metal Cathodes: recovery

- > QE recovery requires cleaning in situ
 - Laser cleaning
 - Issues: scanning pattern often visible, increases surface roughness
 - H ion cleaning (removes C)
 - Ozone cleaning (reacts with C- cleaning)
- > Issue:
 - Could the cleaning possibly makes the surface more reactive (?)
 - shorter lifetime and harder to clean
 - Load-lock required for Cu cathodes as well?
- > Is there some way of passivation the surface?



Emission Model Issues

> Thermal emittance

- a factor of 2 difference between prediction and measurements cathode surface roughness

> Surface roughness

- emittance growth due to spatial modulation $\sim \sigma_x \frac{2}{\sqrt{\pi}} \frac{1}{n_s} \sqrt{I/I_0}$ (n_s is the spatial frequency)
- emittance growth due to surface roughness larger for higher gradients

> Cathode contamination

- enhanced by UV of lasers

> What's about some standards to reduce parameters for modeling?



Cathodes suitable for SC guns

- > The aim to use SC technology is high rep rate
- > SC cathodes
 - Nb or Pb
 - Issue: QE and thin film stability (Pb)
- > Non-sc cathodes
 - Require isolation (eg. Choke design)
 - Doing this to have high QE
- > Having exchangeable cathodes is an operational must
- > High Rep.Rate or cw requires high QE cathodes
 - $QE = 1\% \rightarrow 50\text{ W UV for } 1\text{ mA cw current (300 W of IR } 3\text{ kW with } \times 10\text{ overhead)}$
- > Promising results at HZDR with Cs_2Te in SC gun



Future ideas from the BLN Workshop

- > Cathode type
 - Semiconductors are efficient
 - Metals are fast
- > How can we get the best of both?
- > Metals with coating to lower work function or increase photon absorption?
 - UCLA: MgF_2 coated Cu -> reduce reflectivity from 80 to 15 %
 - ANL: MgO on Ag(001) to reduce work function from 4.7 to 2.9 eV
 - LBNL: matching laser wavelength to surface plasmons to increase absorption
 - CsBr coating on Nb increased QE from $<10^{-6}$ to $2 \cdot 10^{-4}$
- > Collaboration
 - material science techniques
 - load-lock sharing
 - cathode recipes
 - virtual library to store all this information - photocathode.org





Thank you all for participation

EUROFEL Workshop on Photocathodes
for RF guns

March 1-2, 2010
Lecce, Italy