PRODUCTION AND STUDIES OF PHOTOCATHODES FOR HIGH INTENSITY ELECTRON BEAMS

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ABSTRACT

For short, high-intensity electron bunches, alkali-tellurides have proved to be a reliable photo-cathode material. Measurements of lifetimes in an RF gun of the CLIC Test Facility II at field strengths greater than 100 MV/m are presented. Before and after using them in this gun, the spectral response of the Cs-Te and Rb-Te cathodes were determined with the help of an optical parametric oscillator. The behaviour of both materials could be described by Spicer's 3-step model. Whereas the threshold for photo-emission in Cs-Te was shifted to higher photon energies, that of Rb-Te did not change. Our latest investigations on the stoichiometric ratio of the components are shown. The preparation of the photo-cathodes was monitored with 320 nm wavelength light, with the aim of improving the measurement sensitivity. The latest results on the protection of Cs-Te cathode surfaces with CsBr against pollution are summarized. New investigations on high mean current production are presented.

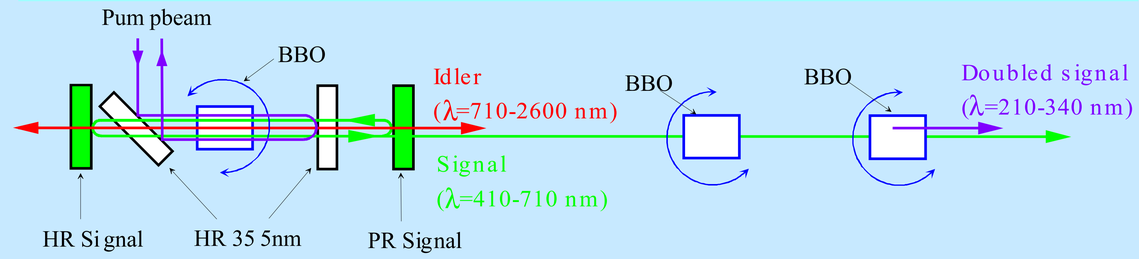
Spectral investigations of bialkali-tellurides photocathodes

The spectral response of photocathodes can be described in the model of Spicer by:

$$QE = \frac{c_1(h\nu - E_T)^{\frac{3}{2}}}{c_2 + (h\nu - E_T)^{\frac{3}{2}}}$$

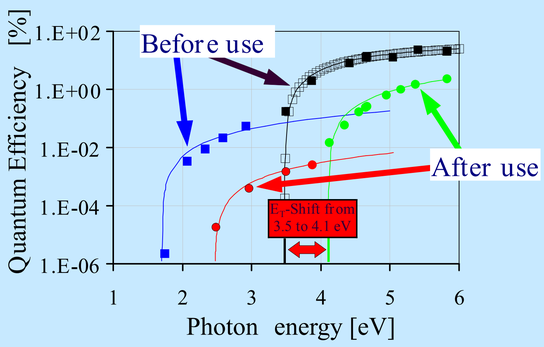
E_T is the photoemission threshold,
c_1 and c_2 are constants,
$h\nu$ is the incident photon energy.
A tunable lightsource is needed to measure spectra.

A frequency doubled OPO, pumped by the third harmonic of a q-switched Nd:YAG was build to produce the necessary wavelengths for these experiments.

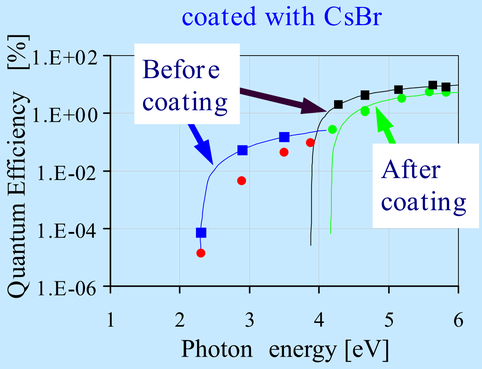


To interpret the spectra in terms of Spicer's theory, it was necessary to split the da a into 2 groups, one at "low photon energy" and one at "high photon energy", as shown below. Then, the data can be fitted well with two independent curves, which give two threshold energies. This indicates that there might be two photoemissive phases of Cs-Te and Rb-Te on copper.

Standard Cs-Te

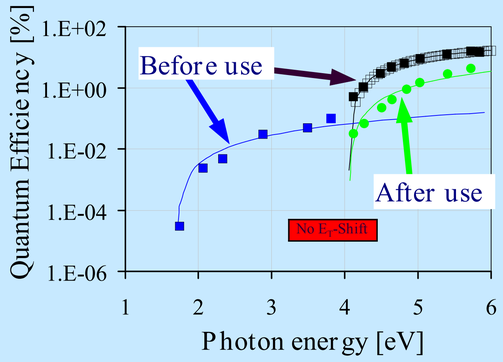


Cs-Te, coated with CsBr



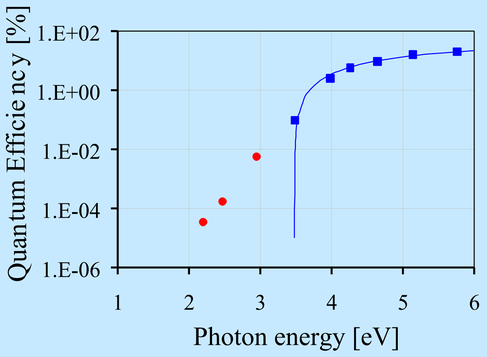
We tested also the protection of Cs-Te with CsBr, without a significantim-provement in lifetime.

Rb-Te



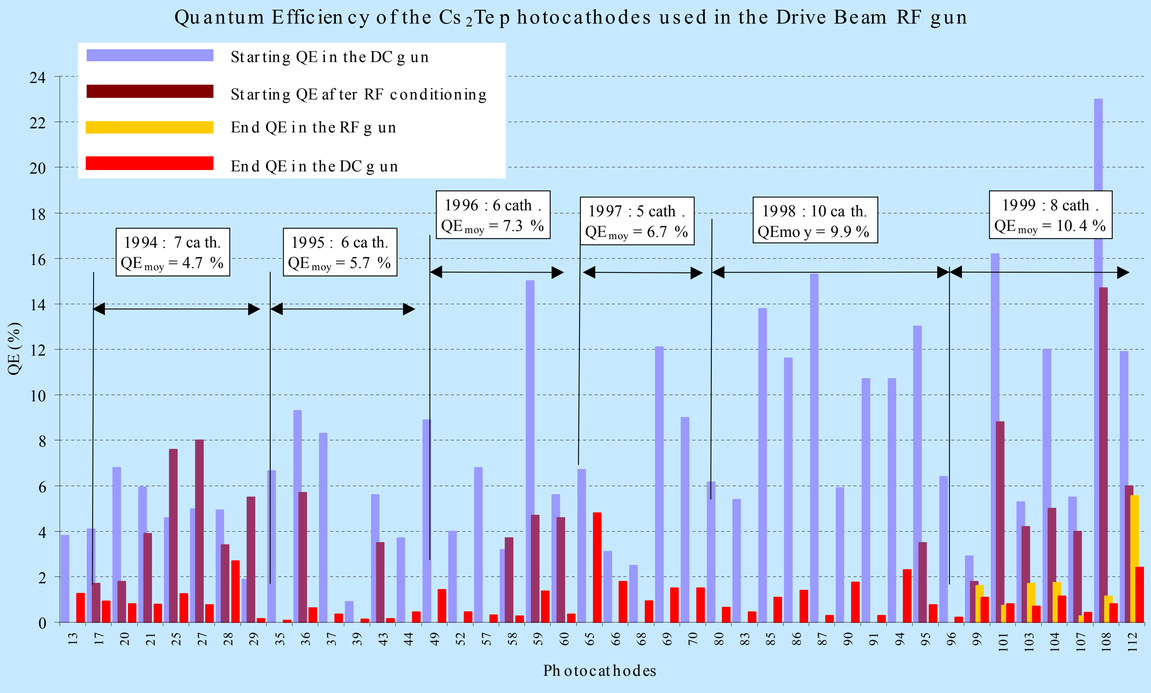
As another type of photocathode material, Rb-Te was used. Due to it's lower affinity, it should be less polluted by the restgas. We didn't see longer lifetimes.

Cs-Te on gold before use



The low energy shoulder disappeared. At the moment in the gun, since 40 days.

Use in the drive beam gun



No correlation between lifetime and initial quantum efficiency can be seen.