Thermal emittance of Cs_2Te Photocathodes

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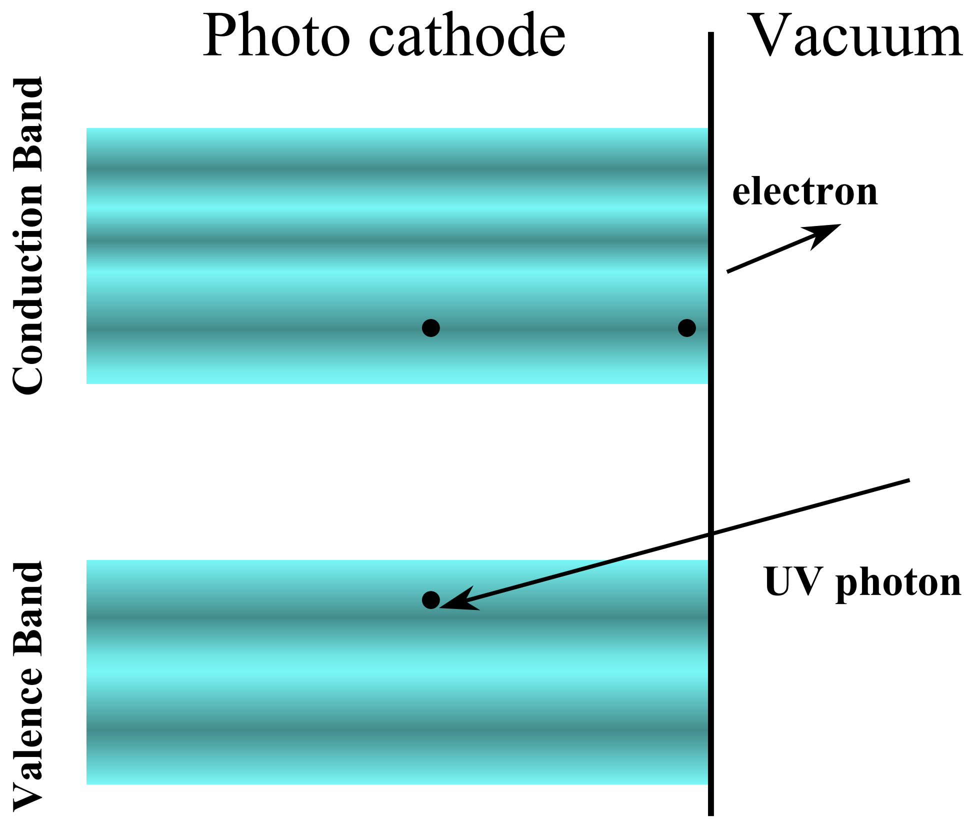
The three step model of photo emission



Step 1: Optical excitation of the electron

Step 2: Migration to the cathode surface

Step 3: Crossing of the vacuum potential barrier

The case of Cs_2Te

Step 1: Optical excitation of the electron

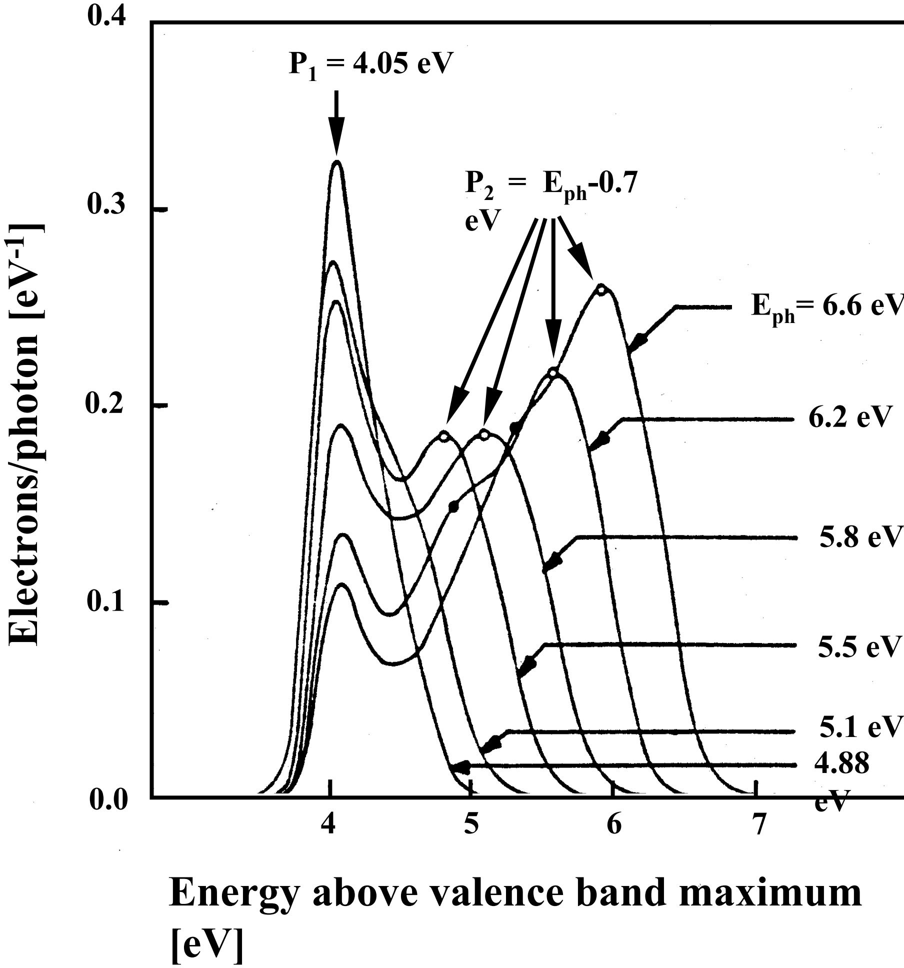
- Photon absorption length < 20 nm.

  ➘ fast response time of the cathode

- Indirect gap transition.

  ➘ final state electron energy $E_f = 4.05$ eV, to some extend independent of the photon energy

The case of Cs_2Te



Energy distributions of photo emitted electrons.
Measurement by Powell et al, 1973.

The case of Cs_2Te

Step 2: Migration to the cathode surface

- Elastic electron-phonon scattering.

◗ No energy loss due to electron-electron scattering, because the electron energy is too low to create a second electron-hole pair.

↖ Energy stays constant, momentum distribution is randomized.

The case of Cs_2Te

Step 3: Crossing of the vacuum potential barrier

- The kinetic energy of the electrons after crossing the vacuum potential barrier is given as:

$$E_{kin} = E_f - E_{Gap} - E_{Electron\ Affinity} = 0.55\ eV$$

Assuming an isotropic emission (worst case) the thermal emittance is given as:

$$\varepsilon_{n\ rms} = \sigma_{rms} \sqrt{\frac{2E_{kin}}{m_0 c^2}} \cdot \frac{1}{\sqrt{3}} = 0.64\ \pi\, mrad\, mm$$

for $\sigma_{rms} = 0.75$ mm