Contribution ID: **438** Type: **Oral Presentation**

Theory and Applications of Transmission Mode Metal (Aluminum) Photocathode

Saturday, 11 June 2011 16:40 (20 minutes)

Although metal photocathodes show very low quantum efficiency (< 10-4), they are often used in applications which require a robust, easy-to-handle, but well characterized electron source. External and easy producibility, stability in air, and their process compatibility (high temperature tolerance) make metal cathodes indispensible for many tasks. Injector guns for accelerators, test cathodes for multi-channel plates or MEMS electronics applications are only a few prominent examples. Additionally, metal cathodes show an ultrafast response in the femto-second range making this class worthwhile to study in detail. In contrast to most previous work we are focusing on transmission mode cathodes, especially aluminum ones.
We have derived a quantitative model of the quantum efficiency for transmission mode metal cathodes which permits to optimize the geometry of these cathodes. The model includes reflectance, absorbance, optical penetration depth and a simple estimation of the escape depth of the photo-electron based on the mean free path of the photo electron and the surface barrier. To test the model we grew a set of photo cathodes with different thicknesses. We will present these results and will elucidate the influence of surface modifications, such as oxidation on the cathode performance. We will also discusses pathways which will include ab-initio calculations to determine the escape path of the material.

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Session Classification: Photon Detectors

Track Classification: Photon Detectors