Accelerator Seminar

“Alkali Antimonide Photocathodes Using Co-deposition and Effusion Source”

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Some proposed experiments and some next-generation accelerator designs require very high electron beam currents, ranging from 10 to 100 mA, and even higher. For example, consider the Dark Light experiment – which we hope to conduct at the Jefferson Lab energy recovery linac (aka JLAB FEL) – aimed at searching for dark photons and operating at 10 mA. Jefferson Lab’s other proposal on Electron Ion Collider, MEIC, requires an electron gun feeding 100 mA to an energy recovery linac that will be used to cool a proton beam. It seems unlikely that GaAs photocathodes can satisfy these ambitious projects because residual gas within the photogun vacuum chamber becomes ionized by the extracted electron beam, leading to ion-bombardment of the delicate photocathode, and severely limiting the operating lifetime of the gun. But recent experiments, including one conducted at Jefferson Lab have shown that alkali-antimonide photocathodes are far less sensitive to ion bombardment than GAAS photocathodes. In this talk, we report successful manufacture of CsK2Sb photocathodes having maximum QE ~10% at 532 nm, using an “effusion source”, which was a common device used on GaAs-photoguns during the 1970’s and 1980’s, and offering some advantages over other commonly used alkali sources. The high-capacity effusion source enabled us to successfully manufacture alkali-antimonide photocathodes via the co-deposition method, and using relatively thick layers of antimony (>100 nm thick). We believe co-deposition supports the formation of alkali-antimonide photocathodes having a more optimized stoichiometry compared to manufacture using sequential deposition. We also speculate that the antimony layer serves as a reservoir, or sponge, for the alkali. Thick Sb layers require more alkali, and photocathodes grown with thick Sb layers exhibit the best low-voltage lifetime. A scanning electron microscope was used to evaluate Sb-layer morphology, as a function of Sb-layer thickness. Thin Sb layers provide a relatively smooth amorphous surface, whereas thick Sb layers appear pourous and comparatively rough.

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Jefferson Lab

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