Contribution ID: **588** Contribution code: **SUSB013** Type: **Student Poster Presentation**

Development of Bi-Alkali antimonide photocathodes for implementation in a 1.3 GHz superconducting rf photo-injector

Sunday 25 August 2024 16:00 (2 hours)

Electron beams with low emittance are vital for a wide range of accelerator-based applications, including free-electron lasers, Thomson scattering sources, and ultrafast electron diffraction. Superconducting Radio Frequency (SRF) photo-injectors can produce low-emittance electron beams, particularly in continuous wave (CW) operation. Among the various photo-emissive layers, bi-alkali antimonide is favored for its high quantum efficiency (QE) and compatibility with visible light wavelengths. In 2022, an SRF photo-injector system, including a photo-cathode coating chamber, a 1.3 GHz 1.5-cell jacketed cavity, and tuner, was transferred from KEK to FRIB for R&D purposes. R&D at FRIB is oriented toward the integration of advanced photocathodes into an SRF photo-injector. This paper describes modifications to the cathode preparation chamber and first cathode deposition and characterization trials. A K2CsSb film was produced with a notably extended dark lifetime, albeit with a modest QE of approximately 2%. Extensive spectral response analyses of the layer were conducted, along with thorough assessments of measurement procedures and hardware. This presentation offers insights into the factors contributing to the low measured QE and describes plans for improving the cathode preparation chamber and the experimental procedures.

Footnotes

Funding Agency

Work funded by Michigan State University
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Session Classification: Student Poster Session

Track Classification: MC1: Beam Dynamics, Extreme Beams, Sources and Beam-Related Technologies: MC1.2 Electron and ion sources, guns, photo injectors, charge breeders