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Synthesis of ordered Na-K-Sb photocathodes with oxygen-enhanced quantum efficiency

Alkali antimonide photocathodes are recognized for their efficacy as photoemissive materials in electron sources. This study investigates the fabrication of ordered films of sodium potassium antimonide via Molecular-Beam Epitaxy (MBE) and the impact of oxygen on their performance at the PHOtocathode Epitaxy Beam Experiments (PHOEBE) laboratory within the Center for Bright Beams (CBB) at Cornell University. We utilized a co-deposition technique to reduce the Mean Transverse Energy (MTE) while maintaining high quantum efficiency (QE). The synthesized photocathodes were characterized in terms of their QE and crystal structure. QE measurements were taken across the 400- to 700-nm wavelength range to determine their utility in the visible light spectrum. Reflection high-energy electron diffraction (RHEED) patterns confirmed the successful growth of ordered crystal structures for the first time on both Si(111, 100) and STO. The oxygen background was also measured before sample growth and was found to correspond to an increase in photocathode QE in samples using Si substrates. An excess of oxygen still proved to decrease photocathode photoemissivity. Conversely, STO substrates showed QE loss with increased oxygen background, likely due to the contributions of the oxygen within the substrate to the photocathode composition. Additionally, not all oxidations proved detrimental to the photocathodes' photoemissivity. A sample grown on STO, under the same conditions as the sample grown on Si, was able to recover the lost QE. The conditions that lead to this increased resistance are being further investigated.

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