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Advanced growth and characterization of alkali antimonide photocathodes for bright beam applications

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The properties of the photoemitting electron sources are the determining factors contributing to the performance of the most advanced electron accelerator applications such as particle colliders, X-ray free electron lasers, ultra-fast electron diffraction and microscopy experiments. Therefore, low mean transverse energy (MTE), high quantum efficiency (QE) along with long operational lifetime and robustness under high electric fields and laser fluences must be demonstrated by the photocathode for these bright beam applications. Recent investigations have revealed that the epitaxial growth of single-crystal cesium antimonides can be achieved by photocathode growth on lattice-matched substrates. In this paper, the experimental setup for highly promising alkali antimonide photocathode growth by molecular beam epitaxy on lattice-matched substrates and in-situ characterization with reflection high-energy electron diffraction (RHEED) has been presented. To adapt the L-band RF gun of Argonne Cathode Test-stand (ACT) for extensive testing of alkali antimonides in real accelerator conditions, compatible cathode plug design, and smooth transportation process have been developed and described.

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