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Integrated Photonics for Low Transverse Emittance, Ultrafast Negative Electron Affinity GaAs Photoemitters

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Photocathodes exhibiting simultaneous high quantum efficiency, low mean transverse energy, and fast temporal response are critical for next generation electron sources. Currently, caesiated negative electron affinity GaAs photocathodes have demonstrated good overall results. However, due to the nature of the photoemission process and the details of the Cs surface structure, a tradeoff exists. A low mean transverse energy of ˜25 meV can be obtained by using photons with near bandgap energy, at the cost of an unacceptably high response time, or higher energy photons can be used with mean transverse energy of ˜60 meV with acceptable response times of 2-5 ps. Here, it is shown through a calibrated Monte-Carlo Boltzmann Transport Equation simulation that a thin layer of ceasiated GaAs on a waveguide can potentially exhibit photoemission with MTEs ˜30 meV, ultrafast response times of ˜0.2-1 ps, and QE of 1-10%, breaking the traditional tradeoffs associated with bulk negative electron affinity photoemitters.

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