

Quantum Efficiency and Lifetime Study for Negative Electron Affinity GaAs Nanopillar Array Photocathode

Md Aziz Ar Rahman*¹, Md Abdullah Mamun², Shukui Zhang², and Hani E. Elsayed-Ali^{3, 4}

¹ Department of Physics, 4600 Elkhorn Ave, Old Dominion University

Norfolk, Virginia 23529, USA

² Thomas Jefferson National Accelerator Facility, 12000 Jefferson Avenue in Newport News, Virginia 23606, USA

³ Department of Electrical and Computer Engineering, 231 Kaufman Hall, Old Dominion University, Virginia 23529, USA

⁴ Applied Research Center, Thomas Jefferson National Accelerator Facility, 12000 Jefferson Avenue in Newport News, Virginia 23606, USA

Recent studies showed very promising improvement in quantum efficiency (QE) by negative electron affinity (NEA) GaAs nanopillar array (NPA) photocathodes over their flat surface peers, particularly at 500-800 nm waveband. However, a deeper understanding of the underlying physics still requires both theoretical investigation and experimental verification and to fully tap the potential of this type of photocathodes. In this report, several NEA GaAs NPA photocathodes with different size dimension were studied. The diameter of the nanopillars varied in the range between 200-360 nm, height in the range of 230-970 nm and the periodicity varied between 470-630 nm. The QE and photocathode lifetime were measured experimentally. Mie-resonance enhancement was observed at tunable resonance wavelengths. Simulation is also conducted to understand the mechanism of photo-absorption and to predict possible ways to gain significant improvement in the performance with the goal to meet the stringent requirement by the electron sources in large scale electron accelerators for ongoing and future basic scientific research.

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*mrahm008@odu.edu