# Enhancement of Spin-Polarized Electron Emission from Strain-Compensated AlInGaAs-GaAsP Superlattices

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The thickness of the strained photocathode working layer usually exceeds the critical thickness for strain relaxation resulting in structural defects, smaller residual strain and lower polarization. Critical thickness considerations limit the number of superlattice (SL) periods in the working layer and thus the quantum efficiency (QE) of the structures. To overcome this problem, two types of photocathodes have been proposed. The use of a strain compensated SL, whereby the composition of the SL barrier layers is chosen to have opposite (tensile) strain from that of the quantum well layers, allows the total working layer to be considerably thicker[1]. Another way to increase the QE is to integrate the SL working layer into a Fabry-Perot optical cavity[2]. The key feature of such structures is a Distributed Brag Reflector (DBR) at the back side of the photocathode that reflects the incoming circularly polarized light back to the surface where approximately 0.3 of the intensity is reflected into cathode again and so on.

In the present work we combine these two approaches and develop a novel photocathode structure that integrates a working layer based on the strain-compensated InAlGaAs-GaAsP SL into a Fabry-Perot optical cavity.

The photocathode structures were grown on a p-type (100) GaAs substrate by Metal Organic Vapor Phase Epitaxy using trimethyl group III reagents and arsine. The photocathode consists of a DBR mirror containing 22 pairs of alternating $\lambda/4$ plates of AlGaAs and AlAs. On the top of this mirror, a 500nm thick AlGaAs buffer layer is grown that serves as the substrate for the strained SL. The superlattice contains 20 pairs of compressively-strained AlGaInAs quantum well layers and tensile-strained GaAsP barrier layers. On top of the SL working layer, a 6-nm thick GaAs surface layer was deposited with Zn-doping concentration enlarged from $7\times 10^{17}$ cm$^{-3}$ in the working layer to $1\times 10^{19}$ cm$^{-3}$ to achieve negative electron affinity by the well known procedure of surface activation. Two samples have been prepared with and without a DBR layer. We investigate polarized electron emission from the photocathodes with and without a DBR mirror and report a tenfold enhancement of quantum efficiency due to optical enhancement from the Fabry-Perot cavity without degradation of electron polarization.

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