Improved Superlattices for Spin-Polarized Electron Sources

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The main advantage of Superlattice (SL) - based photoemitters is the possibility to vary the properties of the active layer over a wide range by the appropriate choice of layer composition, thickness, and doping profile. The initial polarization P_0 can be increased by choosing structures with a higher valence band splitting. The SL structures with strained quantum well (QW) layers in which heavy and light hole bands, in addition to the strain splitting, are moved aside due to different light and heavy-hole confinement energy in the QW layers, are the best for this purpose. The other benefit of the SLs is the possibility of a precise modulation doping providing small polarization losses during electron escape from the active layer and the band bending region into vacuum. New InAlGaAs/AlGaAs SL were designed, MBE - grown and tested. A polarization P of photoemitted electrons of up to 92% at corresponding quantum efficiency of 0.5% was achieved at room temperature.

A new strained-barrier short-period $Al_xIn_yGa_{1-x-y}As/GaAs$ superlattice with a minimal conduction-band offset was proposed in[1]. The main advantage of such SL results from the band line-up between the semiconductor layers of the SL. The Al content determines the formation of a barrier in the conduction band, while adding In leads to conduction band lowering, so the conduction band offset can be completely compensated by appropriate choice of x and y, while barriers for the holes remain uncompensated. As a result high vertical electron mobility and simultaneously a small spin relaxation rate is achieved while also a large enough valence-band splitting is remained. The optimization of the design of these structures has recently become possible only with the development of more accurate calculation programs. As a result a polarization P of photoemitted electrons of up to 90% at corresponding quantum efficiency of 0.6% was achieved at room temperature.

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[1] A.V.Subashiev, Yu.A.Mamaev, Yu.P.Yashin, and J.E.Clendenin, Phys. Low-Dim. Struct. **1/2** , 1 (1999).