Photoluminescence and Photoacoustic Characterization of Ternary Alloys of $InAs_xSb_{1-x}$ Grown by LPE for Medium IR Photodetectors

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The band-gap energy in semiconductor ternary alloys of the type $InAs_xSb_{1-x}$ can be tuned in the range 0.42-0.24 eV (2.95-5.25 microns) by adjusting the alloy stoichiometry between InAs and InSb. For applications in the detection of polycyclic aromatic hydrocarbons (PAH's), we need to develop the protocols to grow high quality $InAs_xSb_{1-x}$ epitaxial layers with band-gap energy values around 3.0-3.3 microns, the spectral region where the main absorption bands of the PAH's relies. Using the liquid phase epitaxy (LPE) growth technique, we have grown these $InAs_xSb_{1-x}$ layers on top of (100) GaSb substrates, using the Sb-saturation regime for the growth melt, in order to avoid substrate dissolution and the use of very high supercooling temperatures. In order to optimize the lattice-matching conditions between substrate and layer, a series of $InAs_{1-x}Sb_x$ layers were grown with very small variations in the As concentration around 90%, to optimize lattice match between substrate and layer.

Using the photoacoustic (PA) technique we have analyzed the substrate-layer interface in terms of the interface non-radiative recombination (τ_{nr}) times obtained from the analysis of the frequency dependence of the PA phase intensity signal. Higher τ_{nr}'s times means lower non-radiative recombination probabilities; and consequently, better interfaces in terms of defects. We applied these PA measurements to the series of InAsSb layers grown under different growth conditions such as substrate temperatures and melt cleaning protocols. Also, the PA characterization was applied to the series of InAsSb layers with very slight stoichiometry variations to get the best lattice-matched growth conditions. Low temperature photoluminescence (PL) measurements have been used to characterize the layer's crystalline quality through the analysis of the PL spectra, in particular, the detection of exciton-related emission bands. We present all these PA and PL results, discussing their relation to the layer crystalline quality, and interface perfection, both fundamental for the application of these ternary semiconductor alloys in the development of optoelectronic devices.