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Abstract

Effects of GaSb substrate orientation and surface polarity on performance of MWIR photodetectors (PD) were evaluated by comparing devices fabricated on (100), (211)A and B, and (311)A and B oriented substrates. Two types of PDs were evaluated: bulk InAsSb barrier PD with wavelength ~4 µm, and type-II strained layer superlattice (T2SL) PD with wavelength 5.5 µm. Epitaxial structures were grown by solid source molecular beam epitaxy (MBE) on substrates with various orientations side-by-side in the same growth run. Material performance was evaluated by AFM, Nomarski microscopy, x-ray diffraction, 77 K photoluminescence (PL), and PD current-voltage and spectral testing. All wafers demonstrated reasonable surface morphology, with some variability in roughness from wafer to wafer. Bulk nBn devices fabricated on the high-index substrates show a blue shift up to 0.15 µm for both 77 K PL and for spectral cutoff wavelength compared to the same structure on the (100) substrate. Growth on high-index substrates also showed moderate reduction of quantum efficiency (QE) and variations in dark current (J_d). The (311)A and (211)A oriented structures exhibited the most significant J_d reduction, by a factor of ~3 and ~6, respectively. Substrate orientation induces more variation in the T2SL PD parameters, especially in J_d and QE. Here, the (211)B orientation demonstrates a red shift of the PL and cutoff wavelength by about 1 µm. These results suggest that high-index

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