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Strain Analysis and Infrared Photodetector Application of InAs/GaSb Type-II Strained-Layer Superlattices

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Recently, InAs/GaSb type-II strained-layer superlattice (SLS) has emerged as a promising system to realize uncooled infrared photodetector operating at mid- and long-wavelength (MW/LW). In this study, the strain modulation was induced by changing the thickness of InAs/GaSb SLS from [4/4] to [8/21] monolayers (MLs) at a fixed period of 50, and the interfacial and the crystalline strain were characterized by using high-resolution XRD and TEM analyses. The XRD rocking curve showed the satellite peak of SLS well developed up to $\pm 3^{rd}$order and a strain transition from compressive to tensile with increasing thickness of InAs layer. TEM photographs show a minute displacement at the interface of InAs and GaSb layers that may be due to a strain, and an additional ML on each GaSb layer that is supposed to be InSb-like interfacial layer. Using this structure, an InAs/GaSb superlattice infrared photodector (SLIP) was tested for its device application. The device structure with an 8/8-ML SLS active layer with 150 periods was grown by MBE technique, and the proto-type discrete device with an aperture of 200-μm diameter was fabricated by using a standard photolithography. The wavelength and the bias-voltage dependences of detectivity (D*) measured by a blackbody radiation source give that the cutoff wavelength is ~5 μm and maximum D^* (λ=3.25 μm) are ~10^9 cm.$Hz^{1/2}$/W (13 K). The activation energy of 275 meV analyzed from the temperature dependent responsivity is in good agreement with the energy difference between two SLS subblevels of conduction and valence bands (HH1-C) involving in the photoresponse process. This work was supported by KICOS through a grant provided MEST in 2007 (No. 2007-00011) for GRL project.

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