Monolithically integrated InAs/InGaAs dual-band infrared photodetector

Seungwan Woo[1,2], Eungbeom Yeon[1], Jae-Hoon Han[1], Ho Won Jang[2], Daehwan Jung[1], Won Jun Choi[1]
[1] Korea Institute of Science and Technology, [2] Seoul National University

Multispectral infrared photodetectors are crucial components for gathering information about their surroundings because of their ability to detect photons across multiple wavelength regions. [1, 2] In this work, we demonstrate InAs/InGaAs dual-band photodetectors epitaxially grown on an InP substrate for near-infrared (NIR) and short-wavelength infrared (SWIR) detection. A lattice-matched In0.53Ga0.47As active layer was first grown on InP as an NIR absorber, and an optimized InAlAs-based buffer structure was introduced to achieve a smooth surface morphology and a low threading dislocation density (TDD). Then, an InAs active layer was grown on this buffer as a SWIR absorber (Fig. 1(a), (b)). With this growth strategy, we achieved a low root-mean-square (RMS) roughness of 1.3 nm and TDD of 5.8 × 107 cm-2 (Fig. 1(c), (d)). As shown in Fig. 1(e), the high density of misfit and threading dislocations are confined in the InAlAs-based buffer layer. Also, a p-n-p back-to-back diode structure was adopted to simplify device operation complexity and fabrication process. Surface-activated bonding was used to transfer the active layers to a Si substrate, which shows no degradation of material quality (Fig. 2). The fabricated InAs/InGaAs dual-band infrared detector exhibits excellent device uniformity with great bias-tunability and a high room-temperature responsivity of 0.9 A/W at 2 μm (Fig. 3). In conclusion, we report monolithically integrated InAs/InGaAs dual-band infrared photodetectors with a low TDD, broad spectral range, and high-responsivity at room-temperature. This proposed dual-band infrared detector is promising for hyperspectral sensing, self-driving, and computer vision applications.