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Infrared Photodetectors Based on Nanowire Arrays: Towards Far Infrared Region

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Abstract : Nanowire semiconductors are promising candidates for optoelectronic applications such as solar cells, photodetectors and lasers due to their quasi-1D geometry and large surface to volume ratio. The functional wavelength range of NW-based detectors is typically limited to the visible/near-infrared region. In this work, we present electrical and optical properties of IR photodetectors based on large square millimeter ensembles (>1million) of vertically processed semiconductor heterostructure nanowires (NWs) grown on InP substrates which operate in longer wavelengths. InP NWs comprising single or multiple (20) InAs/InAsP QDics axially embedded in an n-i-n geometry, have been grown on InP substrates using metal organic vapor phase epitaxy (MOVPE). The NWs are contacted in vertical direction by atomic layer deposition (ALD) deposition of 50 nm SiO2 as an insulating layer followed by sputtering of indium tin oxide (ITO) and evaporation of Ti and Au as top contact layer. In order to extend the sensitivity range to the mid-wavelength and long-wavelength regions, the intersubband transition within conduction band of InAsP QDisc is suggested. We present first experimental indications of intersubband photocurrent in NW geometry and discuss important design parameters for realization of intersubband detectors. Key advantages with the proposed design include large degree of freedom in choice of materials compositions, possible enhanced optical resonance effects due to periodically ordered NW arrays and the compatibility with silicon substrates. We believe that the proposed detector design offers the route towards monolithic integration of compact and sensitive III-V NW long wavelength detectors with Si technology.

Keywords : intersubband photodetector, infrared, nanowire, quantum disc
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