Andrzej Janaszek

Streszczenie rozprawy doktorskiej w języku angielskim

Long-wavelength infrared (LWIR) higher operating-temperature (HOT) photodetectors suffer from low responsivity due to the low absorption coefficient and short diffusion length in narrow-gap semiconductors. Absorption enhancement is thus highly desired, as it leads to an increase of responsivity and, by allowing for a thinner absorber, a decrease of noise. In this work, several approaches to absorption enhancement have been investigated: surface plasmons-polaritons, optical cavities, and planar waveguide structures. Two detector types based on InAs/InAsSb superlattice were fabricated and characterized: (i) a heterostructural photodiode with a two-dimensional subwavelength hole array (2DSHA) in the top contact metallization, and (ii) an nBn detector with heavily doped N++ semiconductor and a two-dimensional metallic grating. The latter demonstrates a 55% plasmonic enhancement of responsivity at 10.3 μm wavelength and cavity modes that increase responsivity by more than a factor of four, leading to a normalized detectivity of $6.3 \cdot 10^9$ cm$\sqrt{\mathrm{Hz}}$/W at 8 μm wavelength and an operating temperature of 200 K. Finite-difference time-domain (FDTD) and plane wave admittance method (PWAM) numerical simulations enabled understanding of the modes nature and the structure optimization. A key role in the enhancement is played by the N++ semiconductor, whose high doping concentration enables metallic, Drude-like behavior with negative permittivity in the LWIR range.