IMPROVING LIGHT COUPLING IN LWIR T2SL AND QWIP DETECTORS USING METASTRUCTURES: A NUMERIC SIMULATION STUDY

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Quantum well infrared (QWIP) and Type-II superlattice (T2SL) photodetectors present an excellent choice for imaging in the thermal infrared spectral range (LWIR, 8-14 µm). Enhancement of their sensitivity in this waveband can be achieved using field manipulation, which can be realized through techniques of varying fabrication complexity. In this work, we study metastructures in the contact layer because of their compatibility with photodiode array production. In QWIPs, this method is commonly used during diffraction grating fabrication and has for long proved itself as a cost-effective and high-yield solution.

To study the effect of metastructures on light coupling, a finite element frequency domain model has been developed in COMSOL Multiphysics. The model features a QWIP array with a lamellar diffraction grating and pixel sizes ≤30 µm. The impact of variations in grating geometry, photodetector layer thicknesses and refractive index on the light coupling were investigated. Figure 1 shows the field distribution for one set of parameters. Good agreement between the simulated and measured spectral response of IRnova's polarimetric QWIP detector was achieved, validating the model.

The model is transferrable to LWIR T2SL detectors with resonance structures of increased complexity targeting additional resonances, such as surface plasmon polaritons. This provides an excellent tool to optimize these structures, paving the way for broadband LWIR T2SL detectors with enhanced quantum efficiency.