Terahertz imaging with a highly-sensitive quantum dot detector

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Abstract

We report on an application of photon counting detector in the sub-terahertz range of electromagnetic waves for imaging of natural and stimulated radiation emitted by free standing objects. The detector is assembled from a GaAs/AlGaAs quantum dot, electron reservoir and quantum point contact (QPC). Its operation relies on photon-to-plasmon and plasmon-to-charge conversion, followed by charge measurement in a single-shot mode. Individual photons excite plasma waves in the quantum dot, with a resonance frequency determined by the shape of the QD confining potential. The plasma wave decays subsequently by single-particle electron-hole excitations, which change the electrostatic potential stepwise in the close proximity to the QD. The potential steps are probed with the QPC operating as a sensitive electrometer. A studied object is placed on a two-dimensional translating stage. Its emission is projected through an optical window onto the detector attached to a 1K cold finger in a cryostat. Subsequently translating the stage in two space directions we are able to map the distribution of the emitted radiation. The presented technique has a potential for imaging of objects passively radiated in the sub-terahertz range.