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Electronically Tunable Terahertz Detection Using Plasmons

ERIC SHANER, Sandia National Labs

Spectroscopy in the millimeter-wave to THz frequencies has received a great deal of recent interest for security applications and chemical identification. This talk will address detectors that utilize plasmons in high-mobility GaAs/AlGaAs quantum well structures to provide a frequency tunable detector response. While there are various competing detection schemes based on plasmons, here we will cover the grating-gate detector along with a variant having enhanced performance called the split-grating gate detector. The basic device consists of source and drain electrical contacts along with a single grating-gate that spatially modulates both the incident radiation and the carrier density in a quantum well channel. The plasmon frequency underneath the gate lines is tuned by changing the carrier density with an applied gate bias. When this plasmon frequency is in resonance with the incident radiation field, a resonant peak is found in the photoresponse. The split-gate devices work in a similar fashion, except with additional gates in the device used to build larger non-linearities into the system. By doing so, we have observed a several order of magnitude increase in responsivity. Currently, the grating-gate style of detector covers a frequency range from 150GHz to 800GHz at temperatures ranging from 4K to 80K, however, the ultimate frequency and temperature limits of these detectors are not currently known. The ability to tune the detector response by simply changing a gate voltage leads to an attractive spectrometer-on-a-chip where no moving parts would be needed for THz spectral analysis.
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