DETECTION of TERAHERTZ RADIATION in FIELD EFFECT TRANSISTORS

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We present experimental and theoretical study of detection of terahertz radiation in GaAs/AlGaAs heterostructure field effect transistors (FET's) in a wide range of temperatures (8-300K) and for frequencies ranging from 0.1THz to 0.6 THz.

The resonant detection of 0.6 THz radiation by the two-dimensional electron plasma confined in 0.15 μm gate length GaAs/AlGaAs field effect transistors is demonstrated. The critical parameter that governs the physics of the detection problem is wt , where w is the radiation frequency and t is the carriers scattering time. The experiments show that by increasing t (lowering temperature) or increasing detection frequency w (0.2THz to 0.6THz), one can reach a resonant detection condition (wt equal or greater then one) in a submicron gate GaAs field effect transistor. The frequency of this resonant detection can be tuned by external voltage therefore enabling spectral analysis of THz radiation without any gratings , moving mirrors or other spectral elements.

We also present experimental results on non-resonant terahertz detection (wt <1). The results are interpreted using a new theoretical model, which describes the photo-response below and above the transistor threshold. It is shown that the gate leakage current suppresses the detector response in the sub-threshold region leading to a nonresonant maximum in the photoresponse close to the transistor threshold.

Experimental and theoretical results presented in this work allow us to establish the basic physical mechanisms responsible for THz detection in submicron FET's. Generally we present a new type of detectors based on the nonlinear properties of the two-dimensional plasma in field effect transistors . We demonstrate for the first time the possibility of the resonant detection. We discuss also advantages of these detectors over the most frequently used detectors of terahertz radiation - Schottky diodes.