Field effect transistors for terahertz applications

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The interest in using field effect transistors (FETs) for THz applications was initiated at the beginning of the 1990's by the theoretical works of Dyakonov and Shur, who predicted that a steady current flow in an asymmetric FET channel can lead to instability against the spontaneous generation of plasma waves and THz radiation. Later, they had shown that the nonlinear properties of the 2D plasma in the transistor channel could also be used for detection and mixing of THz radiation.

We present an overview of the recent developments (physical ideas and experimental results) concerning the application of FETs for the generation and detection of terahertz radiation. Three main developments will be presented: i) discovery of the boundary instability; ii) observation of the photo-response at high magnetic fields including Shubnikov oscillations and cyclotron resonance; and iii) successful implementation of silicon MOSFETs for THz imaging technology. The first allows explaining most of experimental data and proposing future efficient broadband THz emitters. The second is the most striking manifestation of the importance of plasma waves in THz detection by FETs. The third paves the way toward low-cost efficient room temperature operating THz focal plane arrays. Unexpectedly high and broadband responsivity of the MOSFETs was obtained and used for imaging up to 1 THz.

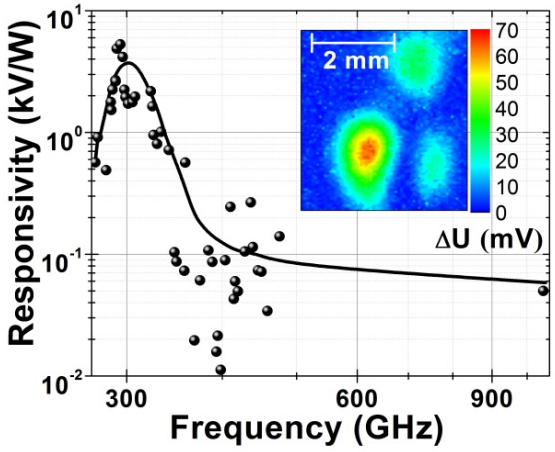

Fig. 1. Responsivity as a function of frequency *f* for 160 nm gate length MOSFETs. Triangles: measured points, solid line: guide for the eye. Inset: raster scan image of the source beam at 1.05 THz, where ΔU is the photo-induced drain-source voltage [1, 2].

1. F. Schuster, D. Coquillat, H. Videlier, M. Sakowicz, F. Teppe, L. Dussopt, B. Giffard, T. Skotnicki, and W. Knap, *Optics Express* **19**, 7827 (2011).
2. F. Schuster, W. Knap, and V. Nguyen, *Laser Focus World* **47**(7), 37 (2011).