Ballistic Field Effect Transistors as Possible Detector of Improvised Explosive Devices

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The explosive detection is used for screening passengers in airports and, in certain cases, for screening their luggage. These measures were introduced in response to the 1988 bombing of Pan Am Flight 103 over Lockerbie, Scotland, the terrorist attacks of September 11, 2001, and the attempted shoe bombing of American Airlines Flight 63 in December 2001. After the July 7 and July 21, 2005, bombing of London subway system, these measures might be eventually extended to include explosive screening on other mass transportation systems and in public and government office buildings.

The detection of Improvised Explosive Devices (IEDs) and suicide belts requires a stand-off explosive detection, which presents a much greater challenge. Varying backgrounds might interfere with the detection signal leading to a large number of both missed detections and false alarms and shrinking the stand-off detection distance to the values below the minimal distance required for prevention of bombing.

Terahertz sensing [[1]] has emerged as one of the most promising techniques for explosive detection, since this non-ionizing (safe for people) radiation should allow for the explosive detection under clothing and, possibly, in dry soil (pending the solution of many technical problems.) Some of the THz detection problems might be solved by using arrays of field effect transistors with nanometer gates that exploit rectification of surface plasma waves (which are the s of the electron concentration in the device channels).

The ideas of using plasma resonances of two-dimensional electrons for tunable emission [[2]] and detection [[3]] of terahertz radiation have been proven experimentally culminating in the recent demonstration of tunable THz emission from a 60 nm InGaAs FET up to 12 THz [[4]] and resonant detection of the THz radiation at room temperature. [[5]] The next challenge is to scale up this technology from using single transistors to using multiple tunable transistor arrays with optimum coupling with incoming THz radiation. Our group is now working on solving this problem.

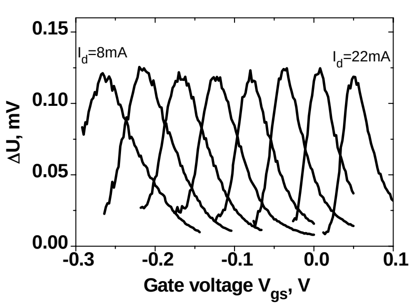

Fig.1. Resonant response to 600 GHz radiation at room temperature. [5]

[1] D. Woolard, W. Loerop, and M. S. Shur, and, Editors, Terahertz Sensing Technology, Volume I. Electronic Devices & Advanced Technology, ISBN 981-238-334-4D. Terahertz Sensing Technology, Volume II. Emerging Scientific Applications and Novel Device Concepts, World Scientific (2003) ISBN 981-238-611-4

[2] Dyakonov M. I. and Shur M. S., Phys. Rev. Lett. 71, 2465, 1993

[3] M. Dyakonov and M. S. Shur, IEEE Trans. Electron Dev. 43, 1640 (1996)

[4] W. Knap, J. Lusakowski, T. Parenty, S. Bollaert, A. Cappy, V. Popov, and M. S. Shur, Appl. Phys. Lett. 84, No 13, 2331-2333, March 29 (2004)

[5] F. Teppe, D. Veksler, V. Yu. Kachorovskii, A. P. Dmitriev, S. Rumyantsev, W. Knap, and M.S. Shur, Room Temperature Plasma Waves Resonant Detection of sub-Terahertz Radiation by Nanometer Field Effect Transistor, Appl. Phys. Lett., **87**, 052107 (2005)