Quantum Dot detector for a Passive Terahertz Imager

P Kleinschmidt[1] , H Hashiba[2], S Giblin[1], A Tzalenchuk[1], S Komiyama[3,*], V Antonov[2]

[1] *National Physical Laboratory, Hampton Road, Teddington, Middlesex TW11 0LW, England*
[2] *Physics Department, Royal Holloway University of London, Egham, Surrey TW20 0EX, UK*
[3] *Department of Basic Science, University of Tokyo, Komaba 3-8-1, Meguro-ku,Tokyo 153-8902, Japan*
** CREST. Japan Science and Technology Corporation (JST), Kawaguchi-shi, Saitama 332-0012, Japan*

To implement a Passive Terahertz Imager probing natural terahertz radiation of an object at room temperature, one need a low temperature detector of high sensitivity, with NEP better than ~ 10^{-19} $Watt/\sqrt{Hz}$. We have designed and tested such a detector. It is based on a lateral semiconductor Quantum Dot (QD) capacitively coupled to a metallic Single Electron Transistor (SET), Fig 1. The QD is an efficient trap for terahertz radiation due to Koch mode plasma resonance. If the potential barriers forming the QD are tuned to a few meV, the plasma oscillations, caused by the photon absorption, quickly decay by the excitation of a small number of electrons out of the QD. These charge excitations of the QD is capacitively coupled to the SET, and detected as telegraph-type switches in its conductance, Fig. 2. We have studied detector at different parameters of the QD and at different temperatures, ranging from 30 to 300 mK. An estimated NEP is ~ 10^{-20} $Watt/\sqrt{Hz}$ at 30mK, which does not change substantially with the temperature elevated to 300 mK. A simple handling and a moderate demands on the fabrication process, combined with flexibility in the design make this detector a good candidate for a Passive Terahertz Imager.

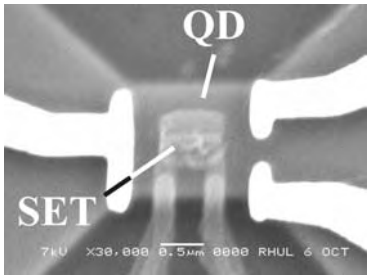

Fig.1 SEM picture of the QD detector. QD is formed by pinch-off of a mesa channel.

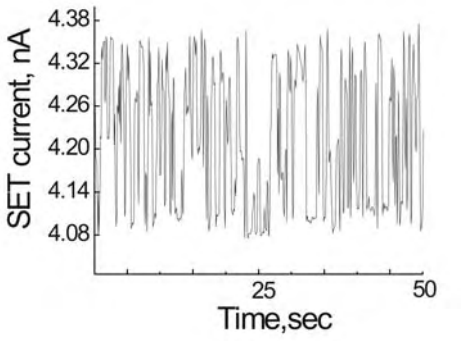

Fig. 2 Telegraph type switches of SET current under radiation.