Waveguide-integrated, plasmonic enhanced graphene photodetectors

J. E. Muench[1], A. Ruocco[1], V. Miseikis[2,3,4], M. A. Giambra[2], D. Zhang[1], J. Wang[1], H.F.Y. Watson[1], G.C. Park[1], S. Akhavan[1], V. Sorianello[2], M. Midrio[5], C. Coletti[3,4], M. Romagnoli[2], A. C. Ferrari[1], I. Goykhman[6]

[1]*Cambridge Graphene Centre, University of Cambridge, 9 JJ Thomson Avenue, Cambridge CB3 0FA, UK*
[2]*Consorzio Nazionale per le Telecomunicazioni (CNIT), Photonic Networks and Technologies National Laboratory, 56127 Pisa, Italy*
[3]*Center for Nanotechnology Innovation @ NEST, Istituto Italiano di Tecnologia, 56127 Pisa, Italy*
[4]*Graphene Labs, Istituto Italiano di Tecnologia, 16163 Genova, Italy*
[5]*Consorzio Nazionale per le Telecomunicazioni, University of Udine, 33100 Udine, Italy*
[6]*Micro- and Nanoelectronics Research Center, Technion – Israel Institute of Technology, Technion City, Haifa 320000, Israel*

jem227@cam.ac.uk

The integration of single-layer graphene (SLG) with Si may improve the performance of key active components required in Data- and Telecoms [1-5]. Waveguide - integrated graphene photodetectors (GPDs) based on the photo-thermoelectric (PTE) effect can directly generate a photovoltage, which could potentially remove the need for transimpedance amplifiers commonly employed in optical receivers, offering a reduction in fabrication cost and power consumption. Here we present a plasmonic enhanced PTE-based GPD integrated with SiN waveguides. Our design employs scalable SLG grown by chemical vapour deposition and relies on two metal gates, centrally aligned to the waveguide, to generate a p-n junction in the SLG and simultaneously support plasmonic guiding in the gap between them (Fig. 1). This leads to enhanced SLG-light interaction, resulting in a steeper electronic temperature gradient across the device. Our GPDs shows an external responsivity up to~12V/W, whilst maintaining high-speed operation (up to 40 GHz) and small device footprints (< 20 μm²), thus paving the way towards SLG integrated receivers.

References

[1] M. Romagnoli et al., Nat. Rev. Mater., 3 (2018) 392
[2] V. Sorianello et al., Nat. Photonics, 12, (2018) 40
[3] I. Goykhman et al., Nano Lett., 16 (2016) 3005
[4] S. Schuler et al., Nano Lett., 16 (2016) 7107
[5] S. Schuler et al., ACS Photonics, 5 (2018) 4758

Figures

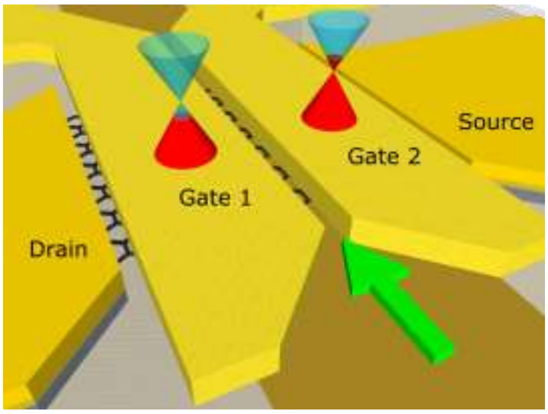

Figure 1: Schematic view of the plasmonic enhanced graphene PD

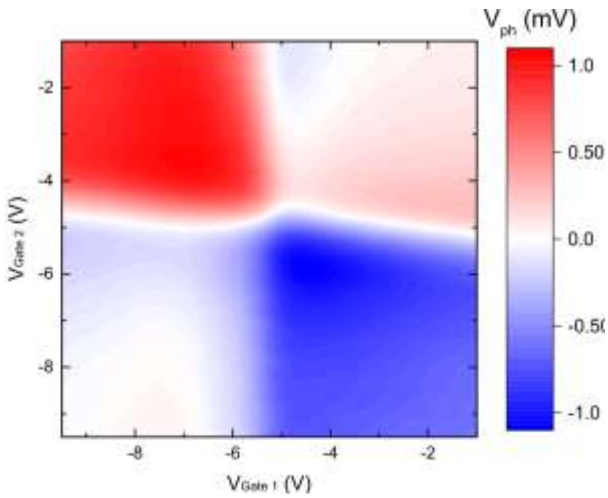

Figure 2: Experimental photovoltage map, measured under zero source-drain bias.