S5-O1

Terahertz rectification up to 3.9 THz by using an Asymmetric Dual-Grating Gate Field-Effect Transistor

E. Abidi[1,*], V. Clericó[1], J. Calvo-Gallego[1], T. Taniguchi[2], K. Watanabe[2], T. Otsuji[3] , J.E. Velázquez[1], and Y.M. Meziani[1,*]

[1] *Nanotech Group, Universidad de Salamanca, Facultad de Ciencias, Salamanca, Spain*
[2] *National Institute of Material Sciences, 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan*
[3] *Research Institute of Electrical Communication, Tohoku University, Sendai 980-8577, Japan*

E-mail: elhadjabidi@usal.es

Terahertz rectification using field effect transistors is gaining great interest for the development of advanced high-speed devices for THz technology[1,2]. Plasmonic rectifiers enable the design of efficient, sensitive, and compact devices capable of operating at THz frequencies[3]. In this paper, we report on THz rectification up to 3.9 THz using an asymmetric dual-grating gate field-effect transistor based on a bilayer graphene encapsulated between two h-BN flakes (Fig. 1(a)). The channel resistance was measured as a function of the bias voltage of the top gates while keeping the bias of the back gate (doped-Si substrate) such that the transistor operates at the charge neutrality point, CNP (Fig. 1 (b)). The back gate is used to create an intrinsic channel at the CNP and the top gates introduce n and p regions with different doping profiles that depend on the applied biases. The maximum value of the channel resistance was obtained for V_{TG1}≈-0.2V and V_{TG2}=0V. Figure 1c shows the obtained mapping of photocurrent versus both top gates biases when the device was excited at 8K with THz radiation at 3.9 THz. The maximum of photocurrent was observed when both top gates were biased with opposite sign, hence when *np* (or *pn*) regions were created along the channel. The creation of regions with different types of carriers leads to the ratchet effect that gives rise to the generation of photocurrent as it was predicted in [4]. Figure 1-d shows the behavior of the signal when the THz beam modulation frequency was increased up to 2 kHz. Only a small decrease of the measured signal was observed at the modulation of 2kHz which shows the high-speed response of the transistor what constitutes a significant advantage of these devices.

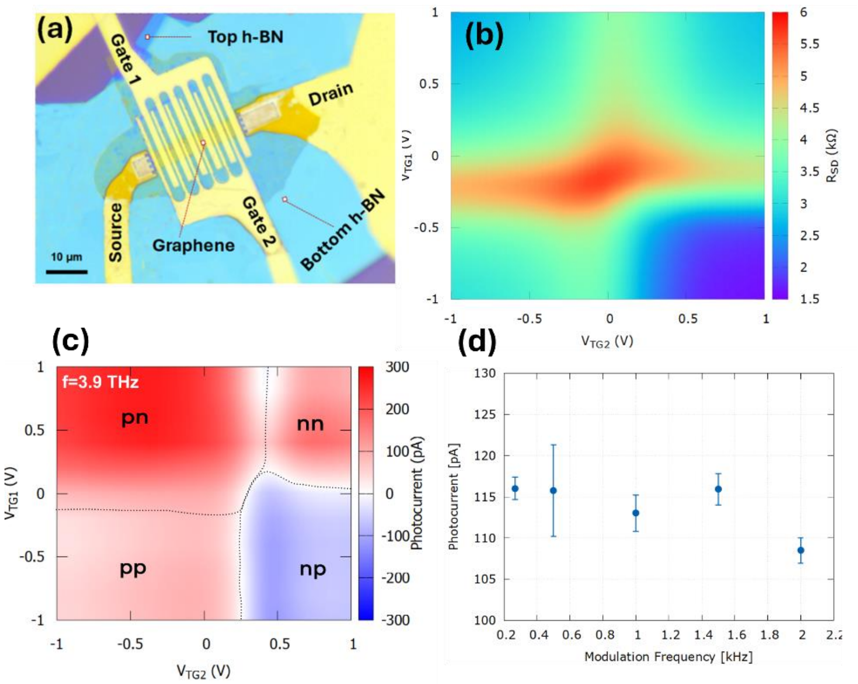

Fig. 1. (a) Optical image of the fabricated asymmetric dual grating gate FET showing the integrated bow-tie antenna. (b) Channel resistance versus both top gates bias voltages (was fixed at a voltage to ensure that the device operates a t the CNP. (c) Photocurrent signal versus both top gates biases under excitation of 3.9THz and at 8K (d) Photocurrent response versus the modulation frequency of the THz beam.

REFERENCES

[1] J. A. Delgado Notario et al., APL Photonics, 5, 66102 (2020).
[2] J. Federici, L. Moeller J. Appl. Phys. 107, 111101 (2010).
[3] R.A. Lewis, J. Phys. D. Appl. Phys. 52, 433001(2019).
[4] P. Olbrich et al., Phys. Rev. B, vol. 93, no. 7, pp. 75415–75422, Feb. 2016,