Proceedings of the 5th World Congress on New Technologies (NewTech'19)
Lisbon, Portugal – August 18-20, 2019
DOI: 10.11159/icnfa19.03

Ultra-Fast Graphene Electronic Devices

Gregory Auton[1,3], Jiawei Zhang[1], Arun K. Singh[1], Ernie Hill[3], Aimin Song [1,2]
[1]School of Electrical and Electronic Engineering, University of Manchester,
Manchester, M13 9PL, United Kingdom
[2] Center of Nanoelectronics and School of Physics, Shandong University, Jinan, 250100, China
[3]Manchester Centre for Mesoscience and Nanotechnology, University of Manchester, Manchester, M13 9PL, United Kingdom
Email: A.Song@manchester.ac.uk

Most effort on graphene electronic devices has so far focused on transistors by, e.g., generating a suitable bandgap in order to achieve a reasonable on/off ratio while preserving the carrier mobility. In contrast to transistors, the functionality of some diodes does not necessarily require a large bandgap. In particular, a nano-rectifier known as the ballistic rectifier can greatly benefit from the extremely long carrier mean-free-path in graphene. Here, we fabricate ballistic rectifier structures by creating an asymmetric cross-junction in a single-layer graphene sandwiched between two boron nitride flakes. A mobility of around 200,000 cm^2/Vs is achieved, ensuring a mean-free-path well beyond that required for the device to operate in the ballistic regime. This enables a very high intrinsic responsivity at room temperature. Taking advantage of the four-terminal device architecture in which the output channels are orthogonal to the input channels, we show that the device noise is hardly influenced by the input and is mainly limited by thermal noise, and this enables an exceptional noise-equivalent power in the order of $pW/Hz^{1/2}$. High-frequency characterisation and imaging experiments have also been carried out up to 640 GHz. Results of our other recent graphene THz nanodevices will also be discussed.

References

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