Photocurrent generation mechanisms for the description of Metal-Graphene-Metal photodetectors' responsivity.

A. Polymerakis, I. Vaggelidis and E. Lidorikis
Department of Materials Science and Engineering, University of Ioannina, Ioannina 45110, Greece

Graphene is a promising material for visible to THz light detection, given its broadband absorption, which allows its use to many photodetection schemes and architectures. The graphene photodetectors with the simplest configuration are the Metal-Graphene-Metal (MGM), which can be considered as the fundamental building blocks for other photodetector architectures and stand out due to their easy fabrication and ultrahigh operating speeds. In such configurations, graphene is placed on a Si/SiO_2 substrate and is contacted by two metal electrodes, acting as source and drain. In this work we computationally investigate the various mechanisms of photocurrent generation such as the photothermoelectric (PTE), photovoltaic (PV), photoconductive (PC) and photo-bolometric (PB) effects on an MGM device, with Au contacts, in the spectral range spanning from visible to near infrared (500-1000nm). We demonstrate our methodology for a series of devices, assuming different channel length, i.e., the area between the two Au contacts, and different graphene doping inside the channel. We distinguish two different operation schemes, one with biased and one with unbiased conditions. Our results show that in the unbiased operation the PTE effect dominates, leading to a maximum responsivity of 15 mA/W, for long-channel architectures. As we apply bias voltage, the other photogeneration mechanisms start to contribute significantly to the photocurrent which further increases the device's responsivity, even for short-channel architectures where the PTE effect is negligible. [1]

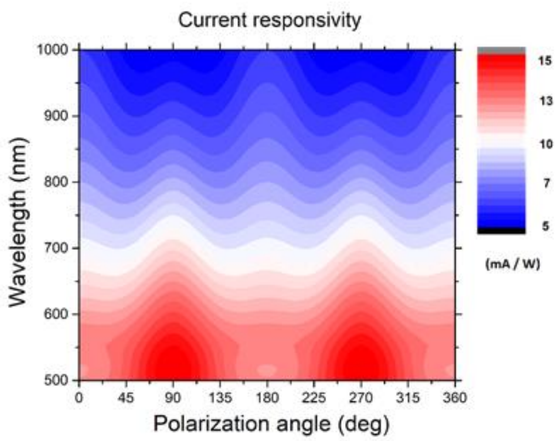

Figure 1: Photocurrent responsivity behaviour of the MGM photodetector

References

[1] Echtermeyer, Tim & Nene, P. & Trushin, M. & Gorbachev, Roman & Eiden, A. & Milana, S. & Sun, Zicai & Schliemann, J. & Lidorikis, Elefterios & Novoselov, K. & Ferrari, A.. (2014). Photothermoelectric and Photoelectric Contributions to Light Detection in Metal-Graphene-Metal Photodetectors. Nano letters. 14. 10.1021/nl5004762.