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PII: S0169-4332(14)00169-X
DOI: http://dx.doi.org/doi:10.1016/j.apsusc.2014.01.117
Reference: APSUSC 27125

To appear in: *APSUSC*

Received date: 1-11-2013
Revised date: 20-1-2014
Accepted date: 20-1-2014

Please cite this article as: F. Ostovari, M.K. Moravvej-Farshi, Photodetectors with armchair graphene nanoribbons and asymmetric source and drain contacts, *Applied Surface Science* (2014), http://dx.doi.org/10.1016/j.apsusc.2014.01.117

Photodetectors with armchair graphene nanoribbons and asymmetric source and drain contacts

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Abstract:

Characteristics of photodetectors with asymmetric source and drain contacts and armchair graphene nanoribbons (a-GNR) channel under monochromatic illuminations of various incident energies in the range of mid infrared (0.1 eV) to solar blind ultra violet (10 eV) are simulated. Simulations show the photocurrent spectrum for the device with an a-GNR of 30 unit cells long and 10 C-atoms wide connected between asymmetric leads made of Au-contacted and Ti-contacted graphenes, under monochromatic illumination of incident intensity 10^3 W/cm^2, exhibits a peak current of 1.897 μA. This peak that is obtained in absence of any external biases, applied to the device terminals, occurs at the energy E=5.02 eV and correspond to the quantum efficiency of 60%. The evaluated responsivity for this photodetectors under zero applied biases equals 13.4 A/mW. The negative and positive local photocurrents are shown peak near the p-type source-channel and n-type drain-channel boundaries under negative gate to source voltages, respectively. Polarities of the local photocurrents alter when the gate-source voltage approaches to the Dirac point, for which the maximum total photocurrent is achieved. Finally, the total device current versus the drain-source voltages obtained under monochromatic illumination, for V_{GS}=0, is shown to shift toward negative values in comparison the dark current. This is because the dark current and photocurrents flow in opposite directions. Simulations are performed, using the non-equilibrium Green's function (NEGF) formalism coupled to Poisson solver.

Keywords: photodetector; graphene nanoribbon (GNR); non-equilibrium Green's function (NEGF); photocurrent; dark current; responsivity; quantum efficiency