WREN 2017

The Workshop on Renewable Energy and Nanotechnology

SANTOS, Renato Bertoni Lardosa[1]; MOREIRA, Mayra Moura[2]; DEL NERO, Jordan[3];

[1]Graduação em Física, Universidade Federal do Pará, Belém, PA, Brasil.

[2]Pós graduação em Engenharia Elétrica, Universidade Federal do Pará, Belém, PA, Brasil.

[3]Departamento de Física, Universidade Federal do Pará, Belém, PA, Brasil.

ABSTRACT

Electron field emission analysis of carbon and silicon nanowires.

In the pursue of more efficient components with which to build highly performing electronic devices, along with new techniques allowing further miniaturization of manufactured products, new electronic devices of nanoscale are being researched [1-2]. Nanowires play an important role since they can be used for providing the necessary connections between nanocomponents and for building the central parts of these components themselves [3]. In the nanometric scale there are nanostructures such as: bulks (3-D), films (2-D), tubes (1-D) and nanoparticles (0-D) [4]. These nanometric structures undergo quantum physical phenomena, thereby exhibiting quantum properties which are less noticeable than those observed in structures of greater dimensions. Such quantum behaviors lead to physical properties of certain materials that may be either unknown or unexpected. Among those properties is the electron field emission, which has been explained by quantum tunneling; therefore, electron field emissions are quantum tunneling [5]. In 1929, Ralph H. Fowler and Lothar Wolfgang Nordheim proposed a theory of field electron emission for bulk metals, known as Fowler-Nordheim tunneling [6]. This model describes how electrons may tunnel into the vacuum as a potential field is applied to the system, thus overcoming the potential barrier, i.e., the Fermi level. If a conductor is placed near this electronic emitter, thus acting as a receiver for the electrons, an electric current may be established, as electrons are propelled into the receiver [7]. Therefore, the distance between emitter end receiver is an important parameter [8]. This phenomenon is very interesting regarding electronic junctions [9-10]. With that in mind, this work analyses the tunnel conducting properties for both the carbon and silicon nanowires. This analysis is carried out by means of molecular modeling of a bulk containing two electrodes, emitter and receiver (or cathode and anode), are kept at a distance, and ab-initio calculations of electronic transport. The results of for both nanowires are plotted and compared.

Keywords: Nanowire; Fowler-Nordheim tunneling; Electron field emission.

References

[1] M. Haselman and S. Hauck. The Future of Integrated Circuits: A Survey of Nanoelectronics. Proc. IEEE, vol. 98, pp. 11-38. 2009.

[2] V. K. Khanna. Integrated Nanoelectronics: Nanoscale CMOS, Post-CMOS and Allied Nanomaterials. Springer. 2016.

[3] K. D. Sattler (Ed.). Silicon Nanomaterials Sourcebook, Volume 1. CRC Press. 2017.

[4] X. Peng (Ed.). Nanowires – Recent Advances. InTech. 2012.

[5] K. D. Sattler (Ed.). Handbook of Nanophysics, Volume 1, Principles and Methods. CRC Press. 2011.

[6] S. Toumi et al. Determination of Fowler-Nordheim tunneling parameters in Metal-Oxide-Semiconductor structure including oxide field correction using a vertical optimization method. Solid State Electronics, vol. 122, pp. 56-63. 2016.

[7] W. Wang et al. Vacuum Potential Barrier and Field Emission Characteristic of Graphene Edges. In 25th International Vacuum Nanoelectronics Conference, Jeju, South Korea, 2012.

[8] A. Hashim (Ed.). Nanowires – Implementations and Applications. InTech. 2011.

[9] C. A. B. da Silva Junior et al. Electronic transport, transition-voltage spectroscopy, and the Fano effect in single molecule junctions composed of a biphenyl molecule attached to metallic and semiconducting carbon nanotube electrodes. Phys. Chem. Chem. Phys., vol. 16, pp. 19602-19607 2014.

[10] A. Bindal and S. Hamedi-Hagh. Silicon Nanowire Transistors. Springer. 2016.