Transport properties of graphene heterostructures

M. Pacheco,[a] J.W. Gonzalez,[a] L. Rosales,[a] P.A. Orellana[b]

[a]Universidad Técnica Federico Santa María, Casilla 110 V, Valparaíso, Chile,
[b]Universidad Católica del Norte, Casilla 1280, Antofagasta, Chile.

monica.pacheco@usm.cl

Graphene nanoribbons (GNRs) are stripes of graphene [1] that can be obtained through high-resolution lithography, by controlled cutting processes or by unzipping multiwalled carbon nanotubes[2]. Different heterostructures (HST) based on patterned GNRs have been proposed and constructed in which the interference quantum effects are exceptionally strong and determine their electronic behavior. Here we present a theoretical study of transport properties HST formed by segments of GNR with different widths connected forming a double crossbar junction [3]. The systems are described by a single-band tight binding Hamiltonian and the Green's function formalism using real space renormalization techniques. We show calculations of the local density of states, linear conductance and I-V characteristics. Our results depict resonant behavior in these HST which can be controlled by changing the geometrical parameters. By applying gate voltages on determined regions of the structure it is possible to modulate the transport response of the system. We show that negative differential resistance (DR) is obtained as a function of the applied gate and bias voltage.

An interesting feature of certain confined nanostructures is the presence of bound states in the continuum (BICs). The search of new systems which could be able to reveal the existence of BICs and with the capability of do measurements of these states is an important field of research. The great advances in the controlled manipulation and measurements reported in graphene based systems, and the feasibility of modified their electronic properties by apply external potentials, suggests that BICs could be observable in graphene HST [4]. In this work we discuss the mechanism of formation of these exotic states and the feasibility to observe them experimentally in symmetrical HST composed by segments of GNRs with different widths.

References

[1] K. S. Novoselov et al. Science **306** (2004) 666 ;C. Berger et. al. Science **312** (2006) 1191.
[2] L. Ci et. al. Nano Res **1** (2008)116 ; D. V. Kosynkin et al . Nature 458, 872 (2009); M. Terrones, Nature **458** (2009) 845.
[3] J. W. González, L. Rosales, M. Pacheco, Physica B: Cond. Matt. **404** (2009) 2773; Eur. Phys. Lett. **91** (2010) 66001.
[4] N. Moiseyev, Phys. Rev Lett. **102** (2009) 167404.