Impact ionization and Auger recombination in graphene under stationary electric fields

José M. Iglesias, Elena Pascual, El Mokhtar Hamham, **María J. Martín***, Raúl Rengel

University of Salamanca, Plaza de la Merced S/N, Salamanca, Spain

mjmm@usal.es

Due to the gapless band dispersion of graphene, a wide phase space for interband transitions is available. Carrier-carrier scattering has a highlighted role in carrier transport in graphene[1]. It can be a source for interband transitions: carrier multiplication in photoexcited samples has been proven[2]. For this to occur, the wavevectors of the two interacting particles must have the same orientation[3] originating the impact ionization and Auger recombination processes depicted in Figure 1. All these mechanisms were included in our in-house Monte Carlo simulator[4]. For the sake of completeness, phonon assisted interband transitions are considered as well. Upon the consideration of a fixed net extrinsic (*n*–*p*) carrier density, we studied the current-electric field characteristics, which reveal a common linear trend at strong fields independent on the doping level and it is mainly determined by the excess carriers created through impact ionization. The consideration of various substrates and level of impurities and defects reveals the strong dependence of these processes with the dielectric environment and the energy relaxation power associated to the substrate surface polar phonons and other extrinsic mechanisms, as seen in Figure 2.

References

[1] X. Li et al., Appl. Phys. Lett. **97** (2010) 082101

[2] T. Plötzing et al., Nano Lett. **14** (2014) 5371–5375

[3] A. Tomadin et al., Phys. Rev. B **88** (2013) 035430

[4] J. M. Iglesias et al., J. Phys. D: Appl. Phys. **50** (2017) 305101

Figures

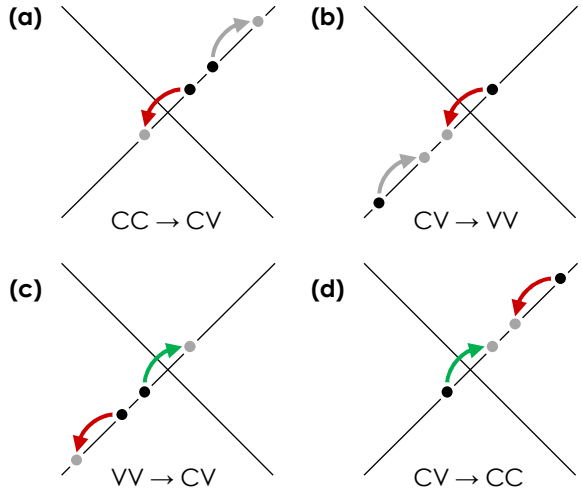

Figure 1: Coulomb mediated interband processes in the collinear limit: Auger recombination (a) and (b), and impact ionization (c) and (d)

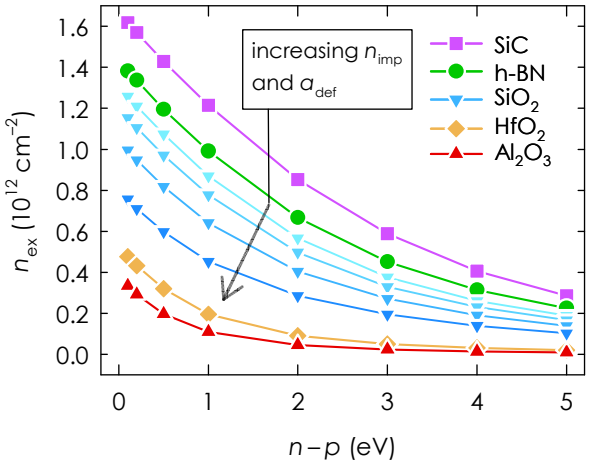

Figure 2: Excess carrier density as a function of the extrinsic doped carrier concentration for various substrates and levels of impurity densities (n_{imp}) and defects (characterized by a_{def}) in graphene on SiO_2

Acknowledgments

This work has been funded by research project TEC2016-80839-P financed by Ministerio de Economía y Competitividad (Spain) and FEDER (European Union), and Junta de Castilla y León (Regional government) and European Social Fund via PhD Grant SA176-15.