Spin-polarized currents in corrugated graphene nanoribbons by Rashba spin-orbit effects

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Spintronics relies on the production of controlled and exploited spin currents by means of the sensitive manipulation of spin in materials. The production of strong polarized can be done by different ways. The use of magnetic electrodes or magnetic field are the most usual to achieve this objective, but at nanometer sizes it is difficult to achieve. Spin manipulation via electric fields is an alternative path explored in the last few years via Rashba spin-orbit coupling (SOC) [1,2,3]. Graphene, a material that presents a wealth of groundbreaking applications is also proposed for this spintronic scenario, such as a quantum spin Hall insulator device. However, carbon presents a very small intrinsic SOC, but it can be enhanced by external fields, proximity effects or by curvature [4].

In this work we have analysed the role that symmetries play in the production of spin-polarized currents in corrugated 2D crystals [5]. In particular, corrugated graphene nanoribbons (GNR) with planar contacts are proposed to form a spintronic device. The curvature along the direction of carriers as it is shown in Fig. 1 can enhance the spin-orbit interactions of the system, provoking an alternate positive and negative effective Rashba SOC, resembling a superlattice.

Our theoretical results foretell that it is possible obtain spin polarized currents in corrugated GNR without breaking time-reversal symmetry, and depending on the number of corrugations and the spatial symmetries of the employed material they can be produced, either to the difference between spin-flip or spin-conserved conductances. All the numerical calculations have been corroborated by a symmetry analysis extending the predictions to general 2D crystals. Moreover the region between two corrugations, where the Rashba SOC is neglected, enhances this effect and therefore great bubbles into material as those made by particles under 2D crystals are of special interest for spintronics.

References

[1] L. Chico, A. Latgé and L. Brey, J. Chem. Chem. Phys. **17** (2015) 16469.
[2] H. Santos, L. Chico, J. E. Alvarellos, and A. Latgé, Phys. Rev. B, **96** (2017) 165401.
[3] H. Santos, A. Latgé, J. E. Alvarellos, and L. Chico, Phys. Rev. B **93** (2016) 165424.
[4] H. Santos, M. C. Muñoz, M. P. López-Sánchez, and L. Chico, Phys Rev B **87** (2013) 235402.
[5] H. Santos et al, In print (2019).

Figures

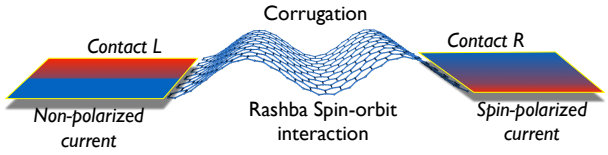

Figure 1: Schematic device composed by two contacts (Left and Right) and a central region with a corrugated GNR. Non-polarized current that comes from left contact goes through a central region where a corrugated GNR is presented and finally a spin-polarized current is produced in the right contact.