Graphene spintronics

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Spintronics is a paradigm focusing on spin as the information vector. Ranging from quantum information to zero-power non-volatile magnetism, the spin information can be also translated from electronics to optics. Several spintronics devices (logic gates, spin FET, etc) are based on spin transport in a lateral channel between spin polarized contacts. We want to discuss, with experiments in support, the potential of graphene for the transport of spin currents over long distances in such types of device. The advantage of graphene over classical semiconductors and metals comes from the combination of its large electron velocity with the long spin lifetime due to the small spin-orbit coupling of carbon. This leads to spin diffusion lengths $\approx$ 100 μm and above.

We will present new magneto-transport experiments on epitaxial graphene multilayers on SiC [1] connected to cobalt electrodes through alumina tunnel barriers [2]. The spin signals are in the MΩ range in terms of $\Delta R = \Delta V/I$ [3]. This is well above the spin resistance of the graphene channel. The analysis of the results in the frame of drift/diffusion equations [4] leads to spin diffusion length in graphene in the 100 μm range for a series of samples having different lengths and different tunnel resistances. The high spin transport efficiency of graphene can also be acknowledged up to 75% in our devices [3]. The advantage of graphene is not only the long spin diffusion length. The large electron velocity also leads to short enough dwell times even for spin injection through tunnel barriers. Our results on graphene can be compared with previous results [5] obtained on carbon nanotubes.

In conclusion, graphene, with its unique combination of long spin life times and large electron velocity, resulting in long spin diffusion length, turns out as a material of choice for large scale logic circuits and the transport/processing of spin information. Understanding the mechanism of the spin relaxation, improving the spin diffusion length and also testing various concepts of spin gate are the next challenges.

References

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