Quantum transport phenomena in encapsulated graphene

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Graphene has been receiving large attention as promising materials for the realization of a spin-valley filter and qubits [1]. However monolayer graphene has no band gap, and electrostatic confinement is not applicable for realization of quantum devices such as quantum dots or quantum point contact (QPC). On the other hands, bilayer graphene (BLG) has tunable band gap by applying the perpendicular electric field, and it is a possible system to realize quantum confined structures such as QPC by using the dual-gating structure [2]. In this study, we have fabricated the BLG-QPC device encapsulated by h-BN with top-split gates (Fig.1(a), (b)). The mobility of the BLG reaches 57,000 cm2/Vs at 0.3K, and quantized conductance plateaus are observed by dual- gating (Fig.1(c)). The level degeneracy of quantized conductance in usual BLG should be g=4 because of mixed spin and valley degree of freedom, however our result and previous research [3] show g=2 level degeneracy. This indicates the broken inversion symmetry state is realized inside of electrostatically squeezed 1D structure with the perpendicular electric field penetrated into the channel region. This valley polarized state may occur valley polarized current as shown in Fig.1(D). We will present our ongoing device results, in context of electrostatically induced open-quantum dot structure or twisted bilayer graphene QPC.

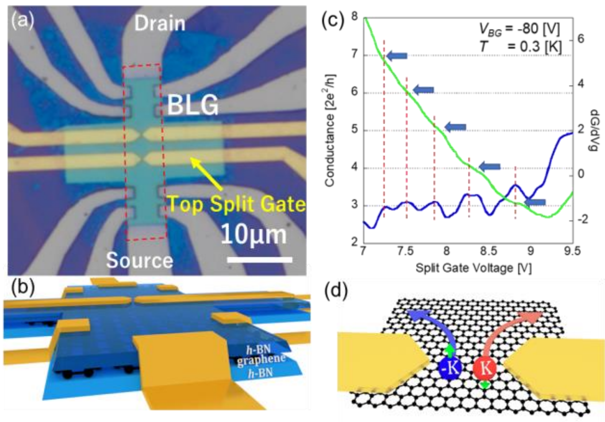

Fig.1 (a) Optical microscope image of BLG-QPC device. Dashed line indicates the edge of BLG. (b) Schematics of our device. (c) Quantized conductance measured in QPC. Green line is conductance plot and blue line is differential conductance. (d) Schematic image of valley polarized current from QPC.

References

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