Observation of topological valley current in non-encapsulated hBN/bilayer graphene heterostructure

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The valley Hall effect (VHE) is a phenomenon in which the carriers in a material move to the opposite edges depending on their valley index. The VHE requires a non-zero Berry curvature which is present only in systems where either time-reversal symmetry or spatial inversion symmetry is broken. It is well known that aligning graphene on hexagonal boron nitride (hBN) with a near-zero twist angle breaks the symmetry of the system. For both single-layer and bilayer graphene, this method has been used to break the symmetry of the system and observe the VHE. The sub-lattice symmetry is broken for single-layer graphene, whereas for bilayer graphene, the layer symmetry is broken. In the case of single-layer graphene, the effect of configuration (i.e., whether the hBN is present on both sides or one side), as well as the orientation of both the top and bottom hBN on the VHE is studied in detail [1-2]. However, for bilayer graphene, although it has been shown theoretically that the configuration, as well as the orientation of the hBN, has an immense impact on the asymmetry of the system [3], experimental studies in this aspect are lacking. K. Endo et al. have studied encapsulated bilayer graphene where the top hBN is aligned with the bilayer graphene and observed VHE [4]. In this work, we conducted valleytronics study on a non-encapsulated hBN/bilayer graphene heterostructure where hBN is present only at the top. The hBN is aligned with the bilayer graphene to break the symmetry of the system. We observed a strong VHE signal through non-local resistance (R_{NL}) measurement (Fig. 1). We also demonstrate that the valley Hall effect can be tuned by applying an out-of-plane electric field, which changes the band gap and the Berry curvature of the bilayer graphene system. We have also performed ab initio calculations to substantiate the experimental observations [5].

References

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Figures

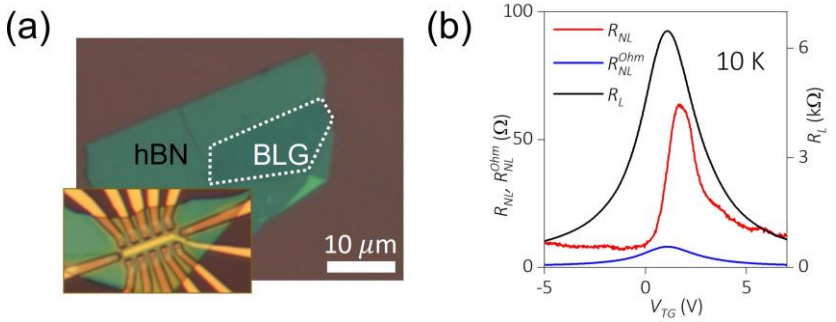

Figure 1: (a) hBN/bilayer graphene heterostructure with the edges aligned. Inset: Optical image of the final device. (b) Measured local (R_L) and non-local (R_{NL}) resistance for the heterostructure.