Title: Tunability of 1/f Noise at Multiple Dirac Cones in hBN Encapsulated Graphene Devices

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Abstract: The emergence of multiple Dirac cones in hexagonal boron nitride (hBN)−graphene heterostructures is particularly attractive because it offers potentially better landscape for higher and versatile transport properties than the primary Dirac cone. However, the transport coefficients of the cloned Dirac cones is yet not fully characterized and many open questions, including the evolution of charge dynamics and impurity scattering responsible for them, have remained unexplored. Noise measurements, having the potential to address these questions, have not been performed to date in dual-gated hBN−graphene−hBN devices. Here, we present the lowfrequency 1/f noise measurements at multiple Dirac cones in hBN encapsulated single and bilayer graphene in dual-gated geometry. Our results reveal that the low-frequency noise in graphene can be tuned by more than two-orders of magnitude by changing carrier concentration as well as by modifying the band structure in bilayer graphene. We find that the noise is surprisingly suppressed at the cloned Dirac cone compared to the primary Dirac cone in single layer graphene device, while it is strongly enhanced for the bilayer graphene with band gap opening. The results are explained with the calculation of dielectric function using tight-binding model. Our results also indicate that the 1/f noise indeed follows the Hooge's empirical formula in hBN-protected devices in dual-gated geometry. We also present for the first time the noise data in bipolar regime of a graphene device.

Reference: Nano Letters, January 14, 2016