Twist-controlled resonant tunnelling between monolayer and bilayer graphene

T.L.M. Lane[12], J.R. Wallbank[12], V.I. Fal'ko[12]

[1]National Graphene Institute, The University of Manchester, Manchester, M139PL, UK
[2]School of Physics and Astronomy, The University of Manchester, Manchester, M139PL, UK
thomas.lane-3@postgrad.manchester.ac.uk

Abstract

We investigate the current-voltage characteristics of a field-effect tunnelling transistor comprised of both monolayer graphene (MLG) and bilayer graphene (BLG) with well-aligned crystallographic axes, separated by three layers of hexagonal boron nitride. Using a self-consistent description of the device's electrostatic configuration we relate the current to three distinct tunable voltages across the system and hence produce a two-dimensional map of the I-V characteristics in the low energy regime. We show that this theoretical model agrees with recent experimental results and can be used to demonstrate the exact band alignment from which each prominent feature arises. The characteristics include regions of negative differential conductance which present an opportunity for the production of highly tunable devices operable in the terahertz regime [1]. Further, the use of gates either side of the heterostructure as well as varying the twist between the graphene electrodes has been shown to offer a fine degree of control over the device's rich array of characteristics [2].

References

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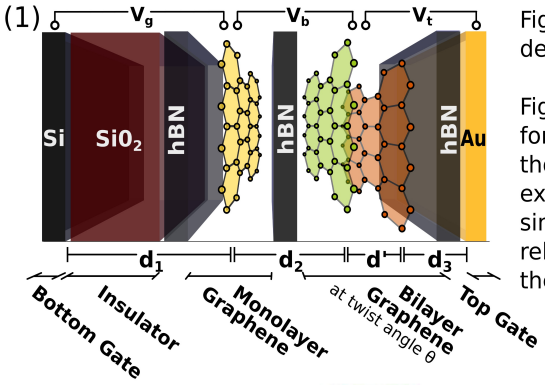

Figure 1. structure of an MLG to BLG tunnelling device with both top and bottom gates.

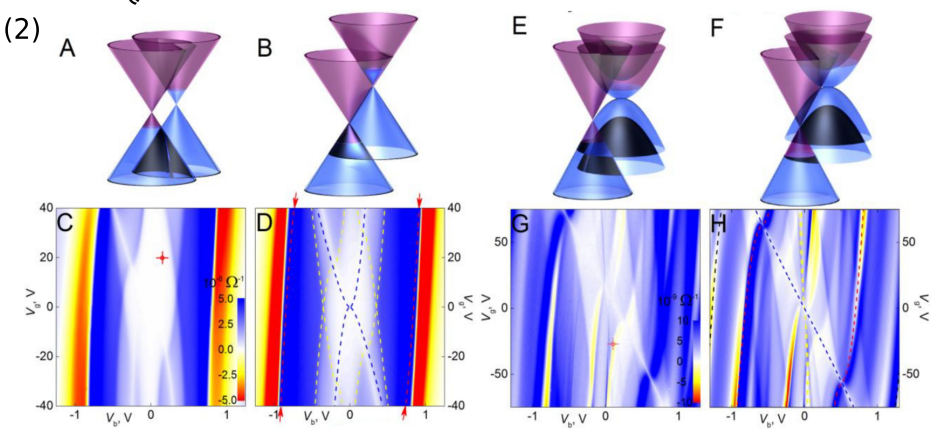

Figure 2. C and D show current characteristics for an MLG-MLG device and G and H depict those of an MLG-BLG structure. C and G are experimental results, whilst D and H illustrate simulated data. A, B, E and F show the relative band alignment for specific features in the characteristics.