Electrical Bandgap Tuning and Spin Transport in Fully Encapsulated Bilayer Graphene Devices: Steps Towards 2D Spin Logic

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The state variable in digital devices has been realised, to date, by measurement of charge. Spintronics offers a new paradigm to improve performance, whereby the quantum spin states of one or more electrons could be used as an alternative state variable. Improvements in transport and control of spin information are necessary for spin logic to be fully realised in graphene devices. Bilayer graphene (BLG) offers the opportunity to electrically control its bandgap[1][2][3] (**Error! Reference source not found.**.a) and, as a result, the spin transport in the channel; thereby potentially enabling fabrication of a graphene based spin field effect transistor. BLG spin transport measurements are conventionally made[3][4][5] using invasive 2D contacts which interface over the width of the graphene channel and, as such, modify the properties of the channel. This type of contact has been shown to cause spin relaxation[6] and inhomogeneous doping[7]. In contrast, our devices incorporate fully encapsulated, high quality BLG with non-invasive contacts, enabled by 1D edge contact technology (Figure 1.b). These only make contact with the edge of the graphene, preserving the channel's electronic properties. Figure 1 shows the resistivity change at low temperature, afforded by a perpendicular electric field (*D*) applied via a top gate, thus revealing the bandgap opening. Spin transport in a non-local spin valve arrangement, has been achieved in the same device and measured as a function of carrier density, revealing signals (ΔR_{nl}) of the order of an ohm at low temperature. Similar measurements at room temperature have also been achieved. The status of our research is presented, along with an outline of future steps paving the way to electrical control of spin transport in a high quality,1D edge contacted BLG device.

References

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Figures

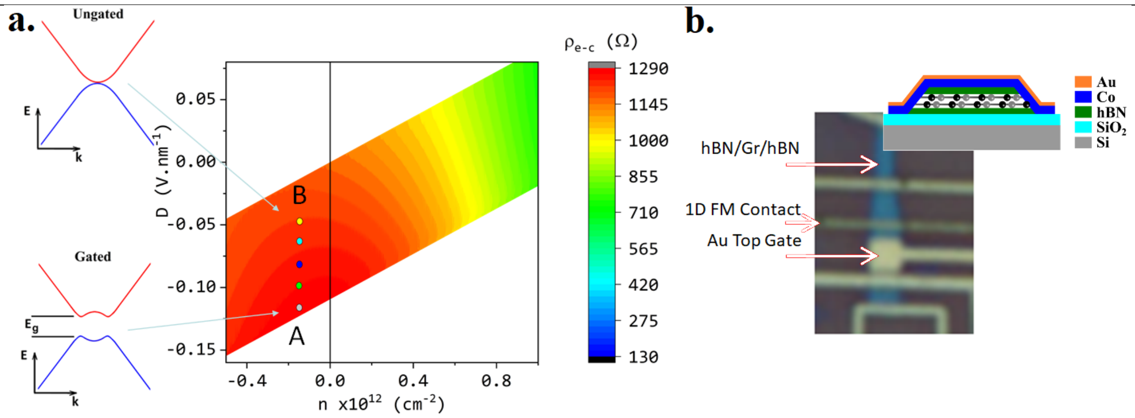

Figure 1: a. Graphene channel resistivity as a function of carrier density and perpendicular electric field, at low temperature (measurement points identified). **b.** Optical image of the BLG device and schematic of its cross-section.