Current transport in graphene/AlGaN/GaN heterostructures

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Graphene (Gr) attracted a huge interest for many device applications, due to many interesting electrical and optical properties. Its main limitation as channel material in MOSFETs is the high off-state current, due to the absence of a bandgap, which hampers its use for switching applications. In the last years, novel device concepts have been proposed to overcome these limitations, like Gr/semiconductor junctions [1] or even heterostructures of Gr layers separated by ultrathin dielectric barriers [2]. These exploit the peculiar properties of the Gr 2DEG (finite density of states, atomic thickness), and the interaction of the 2DEGs in close proximity. In this context, novel devices formed by Gr with semiconductor heterostructures, including an ordinary 2DEG, can be very interesting.

In this work, we investigated the electronic properties of Gr/AlGaN/GaN heterostructures, that can be interesting for high power and high frequency applications. Gr, deposited by CVD on Cu, was transferred on high quality $Al_{0.25}Ga_{0.75}N$/GaN, with ~25 nm thick AlGaN barrier layer. The vertical current transport from Gr to the buried 2DEG was characterized at nanoscale using current measurements by conductive atomic force microscopy (CAFM) and capacitance measurements by scanning capacitance microscopy (SCM) [3]. From these analyses, performed both on Gr-coated and bare AlGaN/GaN regions using different AFM tips metal coatings, the Gr/AlGaN barrier height was extracted, as well as the variation of the carrier densities of Gr and AlGaN/GaN 2DEG as a function of the gate bias.

Novel device concepts based on the properties of vertical Gr/AlGaN/GaN heterostructures will be discussed.

References

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