Chemical sensing using atomically precise graphene nanoribbon heterojunctions

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Using the bottom-up fabrication approach we synthesize a monolayer of multiple aligned heterojunctions consisting of quasi-metallic and wide-bandgap GNRs [1]. The interfaces between GNRs are atomically sharp and the energy band offsets are well-defined. The GNR heterojunctions were characterized by scanning tunneling microscopy, angle-resolved photoemission, and Raman spectroscopy. Integration of GNR heterojunctions into the field-effect transistor geometry allowed us to perform comprehensive transport characterization as a function of bias and gate voltages, channel length, and temperature. Our studies reveal that charge transport in our system is dictated by tunneling through the potential barriers formed by wide-bandgap GNR segments. The current-voltage characteristics are in agreement with calculations of tunneling conductance through asymmetric barriers. Employing a novel experimental UHV transport setup we find that GNR heterojunctions are exquisitely sensitive to adsorbates due to the direct modulation of the tunneling barrier height. Thus atomically-precise GNR heterojunctions can be used for a new sensor concept based on the tunneling conductance.

References

[1] Senkovskiy et al., Tunneling current modulation in atomically precise graphene nanoribbon heterojunctions, DOI: 10.21203/rs.3.rs-74344/v1

Figures

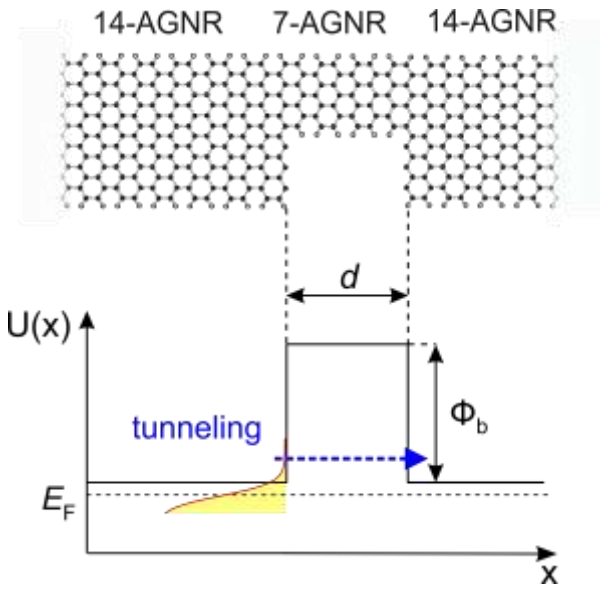

Figure 1: Schematic illustration of an atomically-precise lateral GNR heterojunction. The wide-bandgap armchair GNR of N=7 carbon atom width (7-AGNRs) acts as a tunneling barrier between quasi-metallic 14-AGNRs.