Challenges and Prospects of Graphene Nanoribbons for Quantum Device applications

Riya Sebait[1,2]
Debopriya Dutta[1], Amogh Kinikar[1], Klaus Müllen[3], Michel Calame[2], Roman Fasel[1], Mickael Perrin[2,4], Gabriela Borin Barin[1]
[1]*nanotech@surfaces Laboratory, Empa-Swiss Federal Laboratories for Materials Science and Technology Dübendorf, Switzerland*
[2]*Transport at Nanoscale Interfaces Laboratory, Empa-Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland*
[3]*Max Planck Institute for Polymer Research, Ackermannweg, Germany*
[4]*Department of Information Technology and Electrical Engineering, ETH Zurich, Zurich, Switzerland*
riya.sebait@empa.ch

ABSTRACT

Graphene nanoribbons (GNRs), an ultra-thin strips of graphene, are highly promising material for various quantum device applications due to several key properties such as quantum confinement effects, tunable band gap,[1] presence of unique edge states and their ability to maintain the spin of electrons over relatively long distances.[2] For example, armchair GNRs exhibit tunable bandgaps, transitioning from insulator to semiconductor with width variation while zigzag edges show spin-polarized states, promising for spintronics at non-cryogenic temperatures. However, for the later, characterization is mostly conducted under ultra-high vacuum (UHV) due to reactivity from unpaired electrons. Therefore, pathways for exploiting the exotic properties of such GNRs in device applications have yet to be studied. One fundamental challenge in fabricating GNR-based devices is transferring GNRs from their growth substrate (Au (111)) onto gateable substrates such as SiO_2. To date, only armchair GNRs that are stable in air have been successfully transferred and integrated into devices with different gate arquitectures and electrode materials.[3] Therefore, I will discuss our recent progress on UHV dry-transfer methods (by means of hBN bulk stamp) that would allow the device integration of GNRs with spin polarized states into devices. Additionally, I will highlight the hBN proximity effect on GNRs, particularly in enhancing light-matter interactions, which facilitating the observation of weak vibrational modes such as the radial breathing-like mode (RBLM) and longitudinal compressive mode (LCM), which provide essential insights into GNR width, length, and structural integrity.

Keywords: Graphene nanoribbons; Ultra-high vacuum transfer; hBN proximity, GNR devices.

References

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Figures

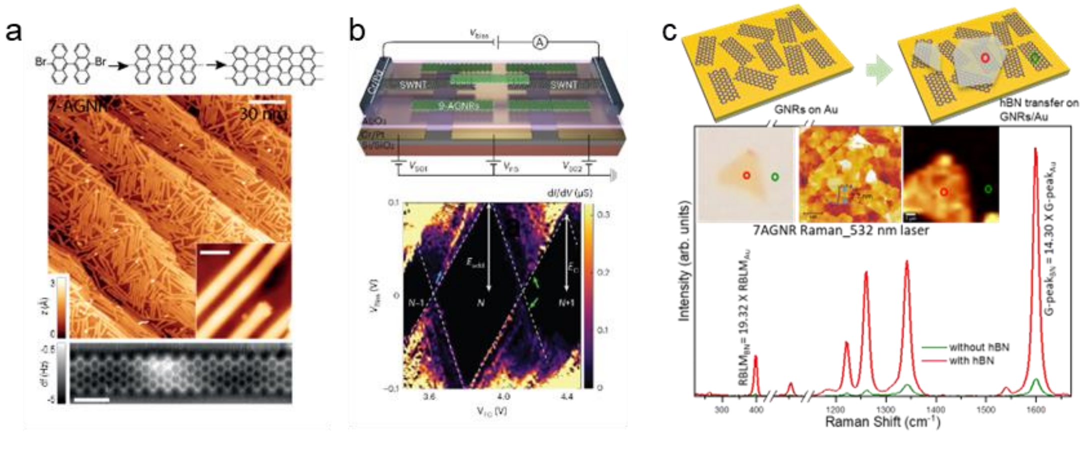

Figure 1: Fig. 1. GNR-based devices. a, Schematic representation of 7AGNRs and corresponding STM and nc-AFM image. b, Schematic of device where CNT used as electrodes (top), transport in 9AGNR transistor shows single electron charging behaviour (bottom). c, Raman enhancement of GNR due to h-BN proximity effect.