DNA Sequencing using Two Dimensional Materials

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Abstract

Major bottlenecks in DNA sequencing are speed of signal acquisition and cost. Molecular electronics[1,2] is promising for the third-generation DNA sequencing. Even though the Sanger method[3,4] is successfully applied to the human genome project, its practical application is limited as accessing individual DNA sequence is time-consuming and expensive. Nanochannel-based ultrafast DNA sequencing[5,6] is an alternative approach based on conductance measurements of a system composed of a nanoribbon of a two-dimensional (2D) material and a nucleobase during the passage of a single-stranded DNA through the nanochannel. The main idea behind the conductance-based method is the appearance of a characteristic dip in conductance when each nucleobase gets π-stacked to the nanoribbon due to Fano resonance[7]. The positions of these dips are measured by the change in conductance of the device when a nucleobase comes in contact with a nanoribbon through π−π interaction. In this poster, we represent and analyze the change of transmission dip as a function of applied bias voltage for the nanoribbons of 2D materials. The employed layered materials are graphene, hexagonal boron nitride (hBN), Silicene, and Molybdenum disulfide (MoS2). We also provide 2D differential conductance maps for nucleobase-AGNR systems via applying both bias and gate voltages to introduce 2D molecular electronics spectroscopy method for unambiguous recognition of various nucleobases.

References

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Figures

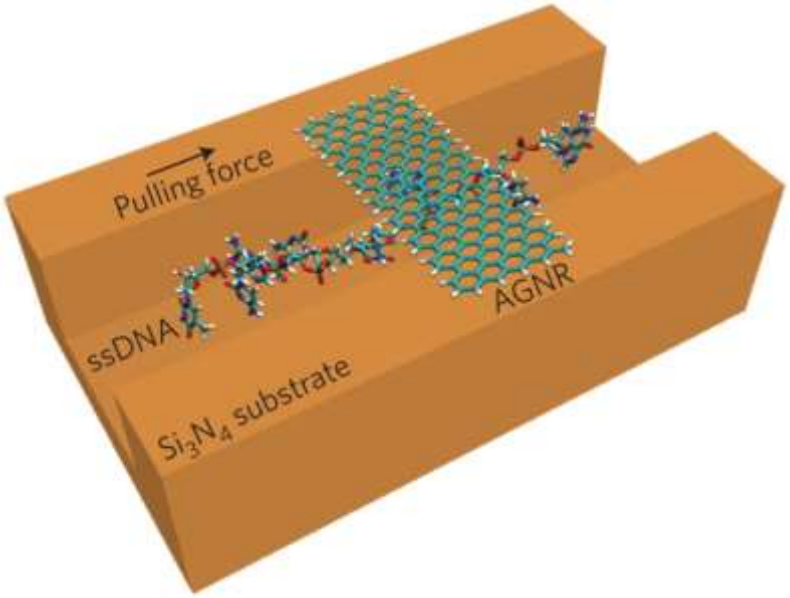

Figure 1: Schematic of a nanochannel device with an armchair GNR (AGNR) through which a ssDNA passes.

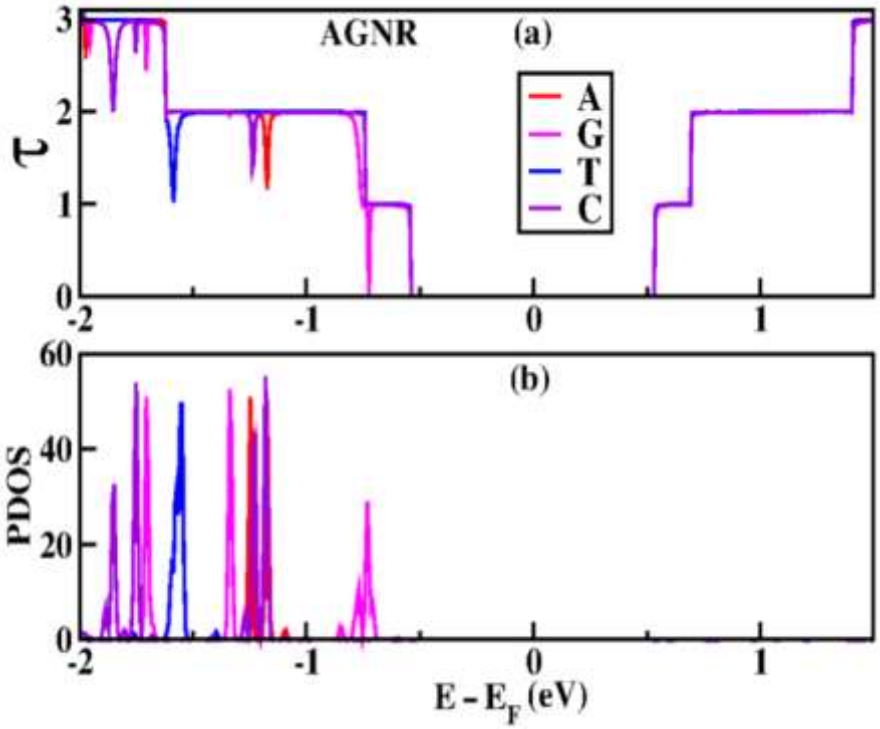

Figure 2: (a) Transmissions and (b) PDOS of AGNR stacked with different nucleobases

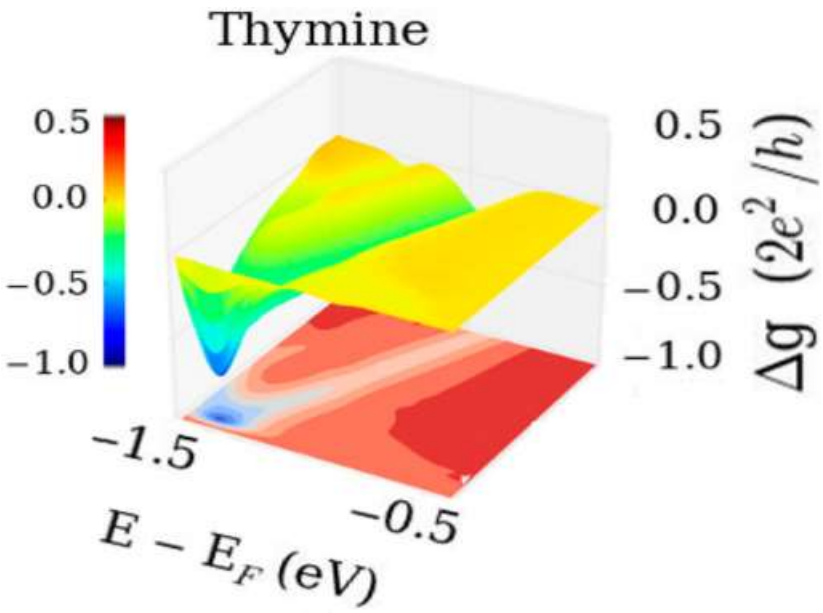

Figure 3: 3D view of the relative differential conductance (Δg) with respect to electron channel energies ($E-E_F$) at varying bias voltages Vb for a Thymine–AGNR system.