Simulation & Optimization of Graphene Nanoribbon Transistors

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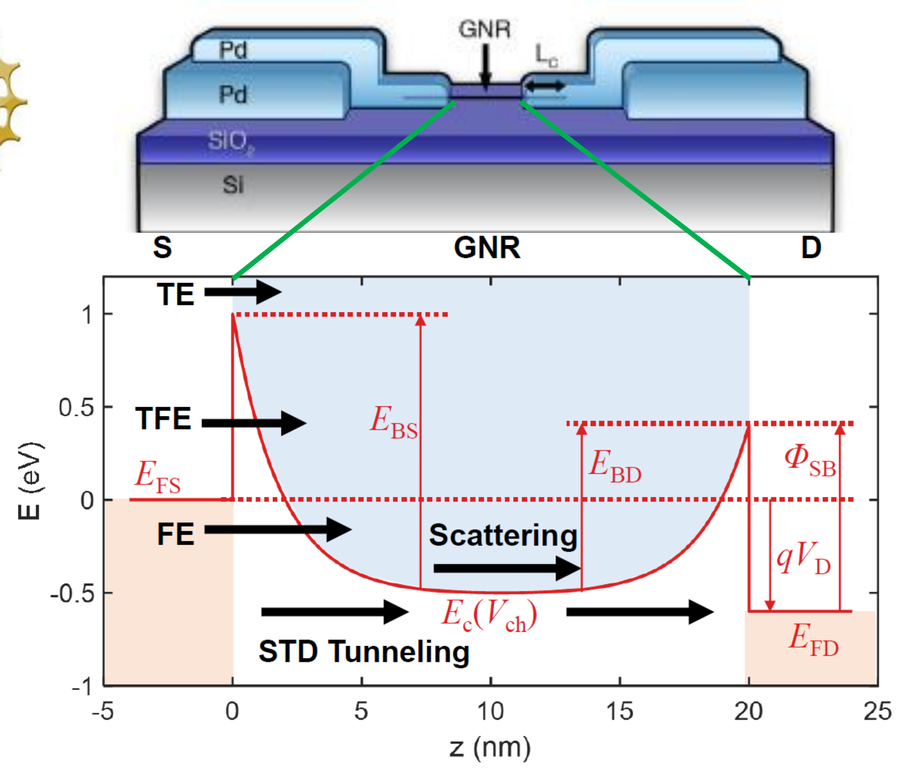
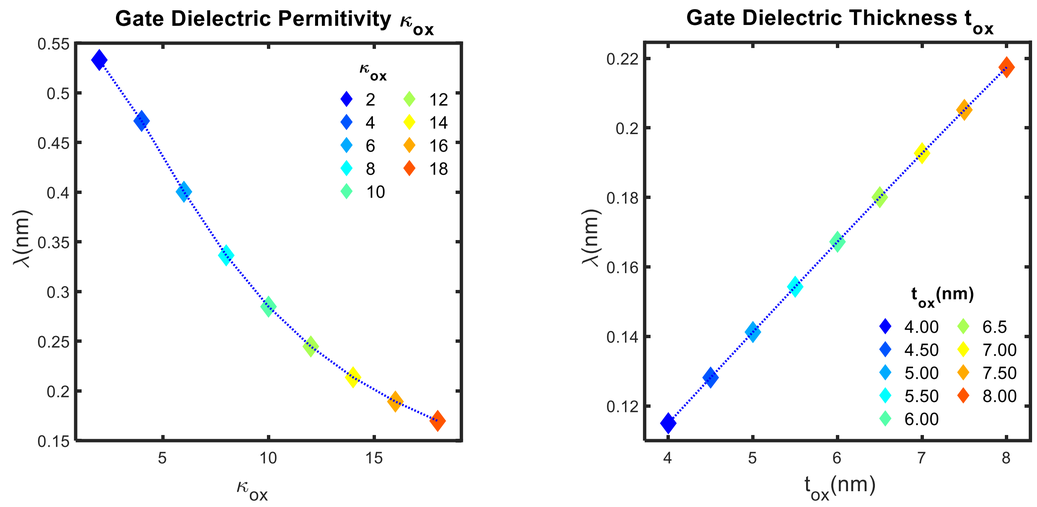
Abstract

Using foundational mathematical models, we can measure the performance of graphene nanoribbon field effect transistors (GNRFETs) through simulation. Using these previous models to calculate device performance given a set of user defined parameters, we analyzed the affects of different materials and fabrication dimensions. In the process of running these simulations the GNRFET can be optimized with the most beneficial attributes that lead to improvements. This process of using iterative simulations saves time and material which will impact construction of GNRFETs for use in circuit applications.

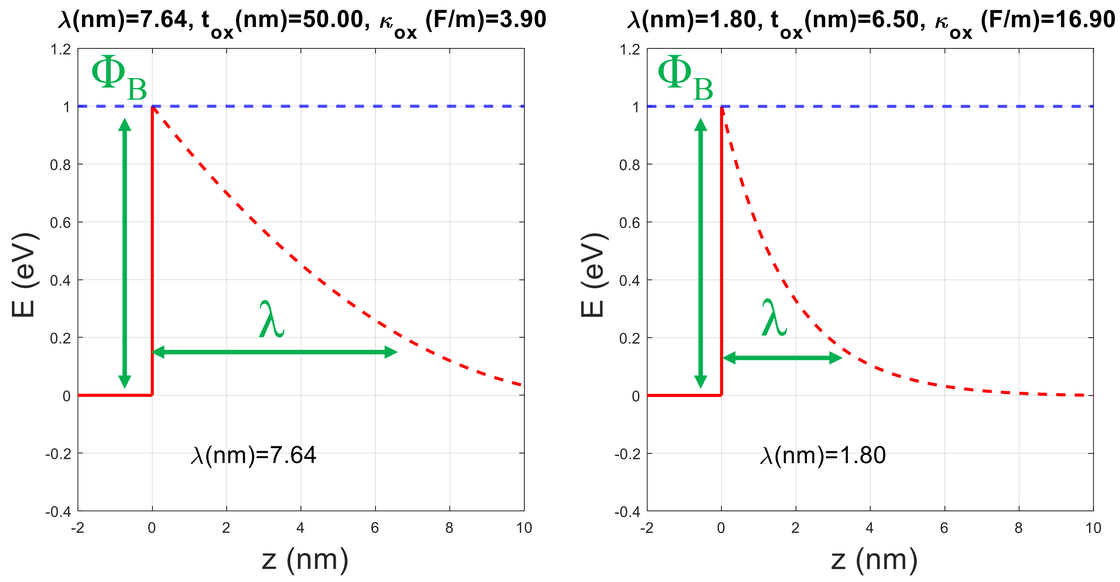


Gate Dielectric Attributes



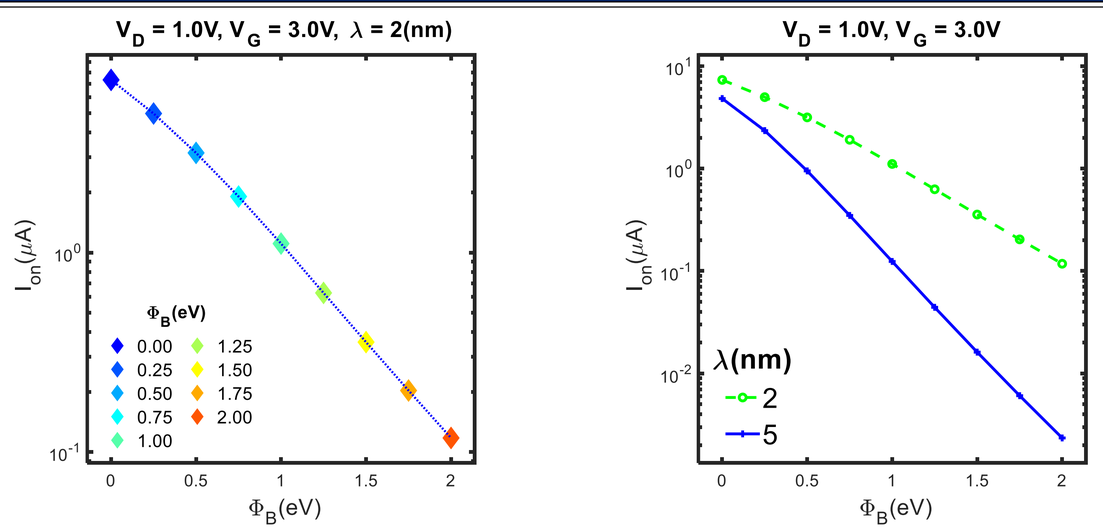
To tune λ, we ran further simulations on how gate dielectric material permittivity and thickness affected the device.

Schottky Barrier Tunneling



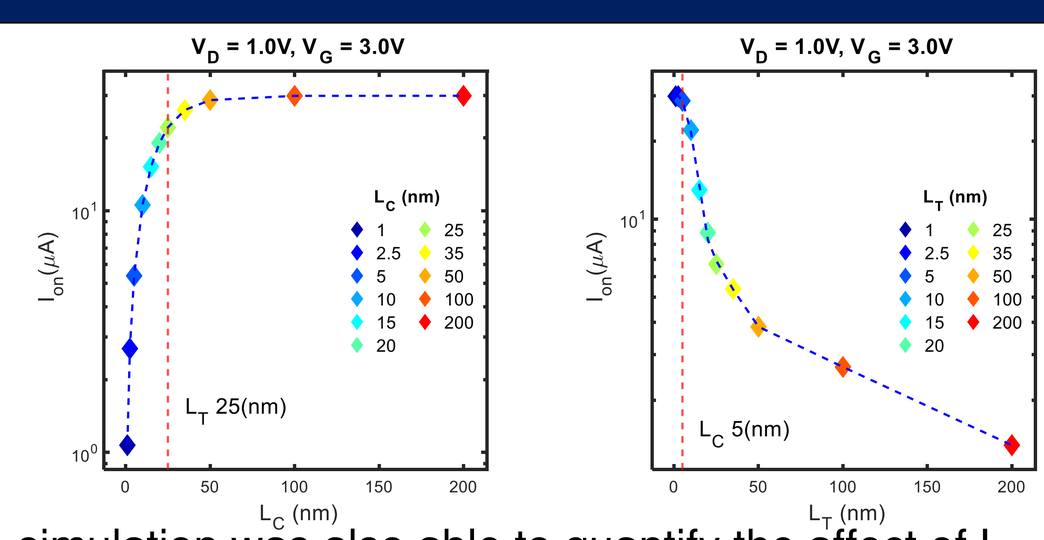
To encourage quantum tunneling we used this simulation to tune this λ and make the device resilient to rises in Φ_b.

Schottky Barrier Height



We ran simulations and noted that as Φ_b rose, I_{on} values degraded. This affect was exacerbated when λ was large.

Contact & Transfer Lengths



The simulation was also able to quantify the affect of L_T and L_C on I_{on}.

Findings

As Schottky barrier height increases, on-current decreases. To increase on-current we can tune λ to encourage electron tunneling. Tuning λ is done in part by modifying gate dielectric thickness and permittivity. Electron transport can be further tuned by modifying the L_C and L_T near the metal-GNR interfaces. When ($L_C > L_T$), I_{on} saturates.

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GNR Diagram: https://doi.org/10.1063/1.4855116