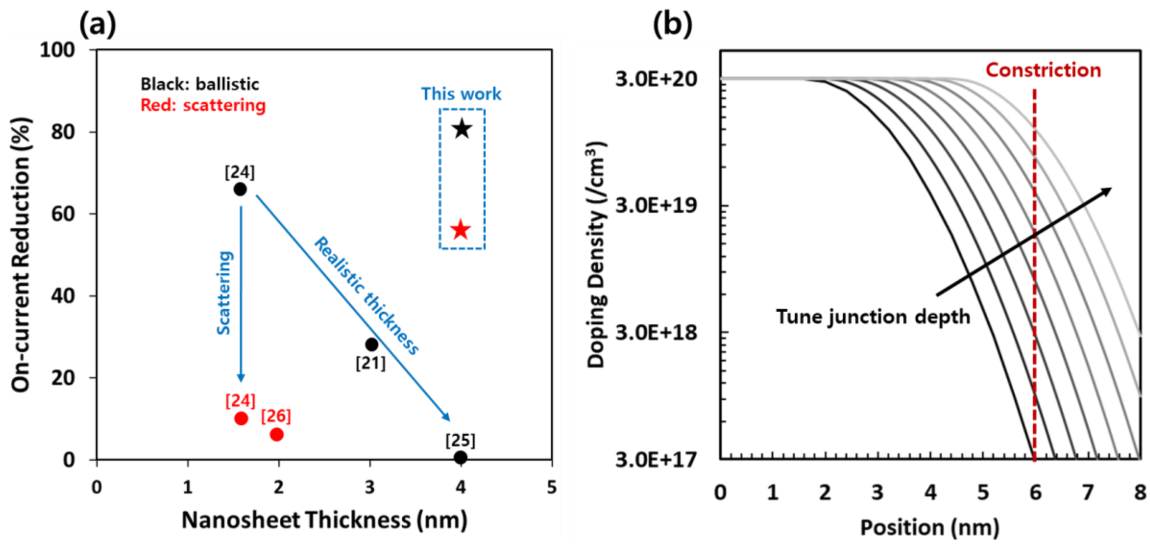
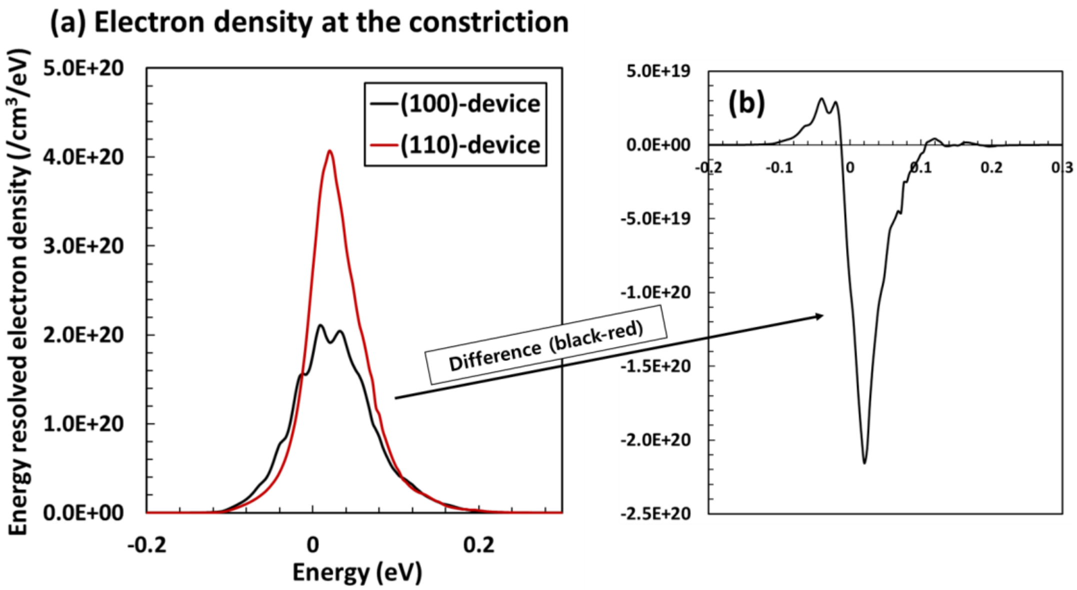
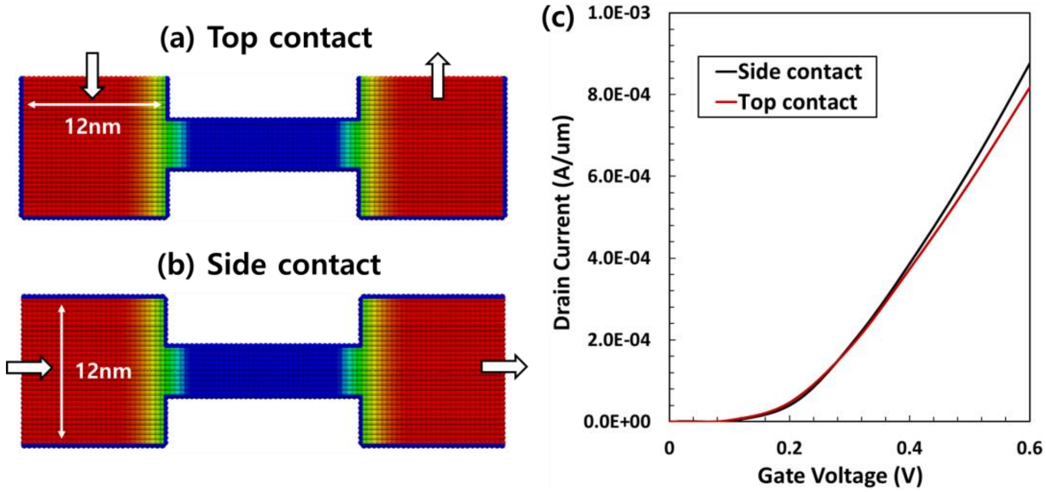


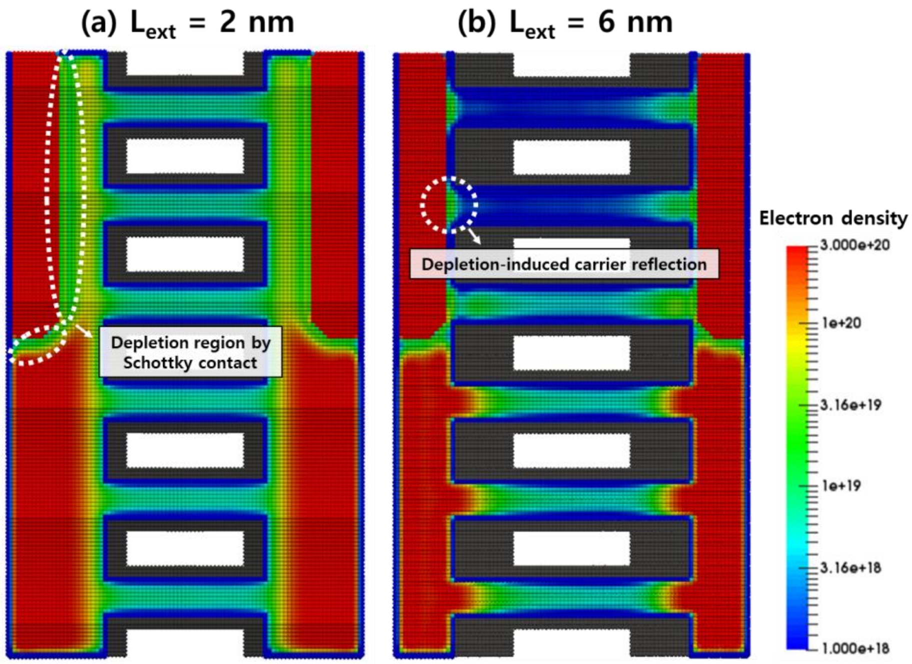

**Supplementary Figure 1. On-current Reduction with Nanosheet Thickness and Doping Concentration Tuning via Junction Depth** (a) On-current reduction due to quantum access resistance. Carrier reflection due to the QAR is suppressed with greater scattering and thicker channel, and it has been considered as negligible in realistic NS thickness. However our results show that QAR can be significantly impact the device performance in low constriction doping cases ($n_{constriction}=3*10^{18}$ $cm^{-3}$) even in thin NS thickness of 3x5nm[25]. Since QAR is greatly overestimated when using the mode space approximation[25], we only compared previous studies that used the coupled mode space or real space NEGF method, or the QTBM method. (b) Doping profile used in this work. We simulate for various doping depth, assuming a same Gaussian decay rate. Thus, by tuning the junction depth, the doping density at the contact remains constant at $3*10^{20}$ $cm^{-3}$, and only the constriction doping density changes.



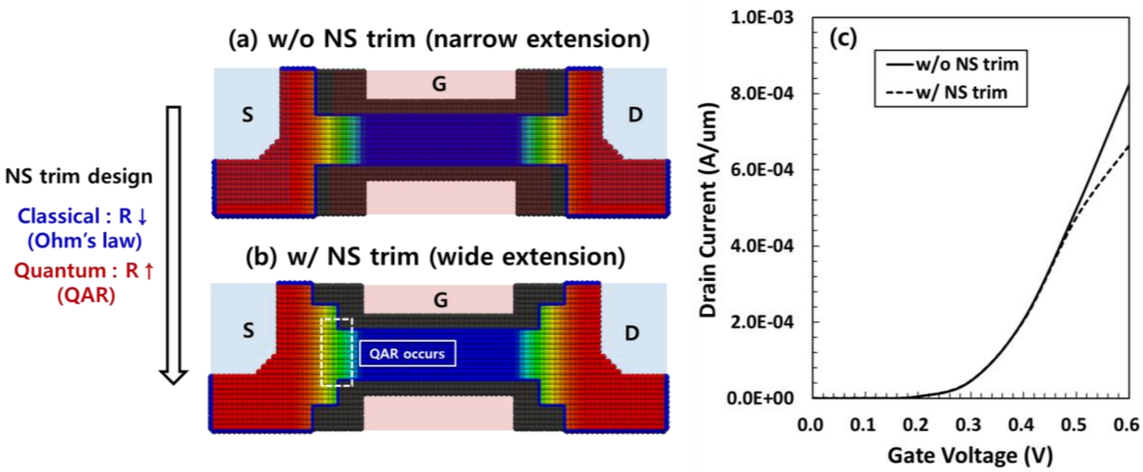

**Supplementary Figure 2. Energy-Resolved Electron Density Depending on Silicon Orientation** (a)-(b) Energy resolved electron density ($V_{DS}$=$V_{GS}$=0.6V) at the constriction. The (100)-device has a lower energy dominant electron density (lower fermi level compared with lowest mode energy) than (110)-device, and it causes stronger carrier reflection.




**Supplementary Figure 3. Device Characteristics Depending on Contact Position** (a) Top contact / (b) side contact devices and (c) its drain-current vs gate-voltage characteristic ($V_{DS}$ = 0.6V). Top contact device has lower drain current than side contact device. It clearly shows that the difference in the current path affects the parasitic resistance. To ensure the most fair comparison, the contact area was set to be the same (12nm), and we used real-space NEGF method.




**Supplementary Figure 4. Impact of Electron Depletion Region Induced by Schottky Contact on Carrier Injection** On-state ($V_{DS}$=$V_{GS}$=0.6V) electron density for (a) short nanosheet extension ($L_{ext}$=2nm) device and (b) long nanosheet extension ($L_{ext}$=4nm) device. The depletion region due to the Schottky barrier affects the carrier injection at the constriction. In particular, in long $L_{ext}$ devices, the nanosheet entrance is located deep in the depletion region and the carrier reflection is maximized.




**Supplementary Figure 5. Nanosheet Trim Design Degrading Carrier Injection** Nanosheet GAAFETs (a) without nanosheet trim and (b) with nanosheet trim, and (c) I-V characteristics. From a classical perspective, the introduction of nanosheet trim seems to reduce the nanosheet extension resistance. However, it causes additional quantum access resistance, and rather increases the total resistance.