Probing the Tunneling Density of States in CVD Grown Monolayer-MoS_2 based Resonant Tunneling Devices

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Abstract: The present work experimentally demonstrates the fabrication of CVD grown monolayer MoS_2 ultra-thin quantum well based double barrier Resonant tunneling device (RTD) architecture well compatible with conventional CMOS fabrication technology. The strongly quantized electronic states from multiple band-minimas in the momentum space in such ultra 2D-sheet along the c-axis sandwiched in between Al_2O_3 tunneling barriers exhibit multiple resonant tunneling peaks thereby enhancing the FWHM of the NDR region as derived from experimental I-V characteristics as well as theoretical joint Invision through Density Functional Theory (DFT) and Non-Equilibrium Green's function (NEGF) visualized via Tunneling Density of States (TDOS). Electrical performances of such RTD, starting from cryogenic to room temperatures, show a significant milestone via a huge PVR (178 at 4K and 24 at RT) and more possible improvement in the field of room temperature quantum technology. Momentum conserved and non-conserved tunneling from highly n-doped Si through multiple valleys of 1L-MoS_2 provides a tremendous opportunity in gate-induced manipulation in Spin-Valley Qubit technology operational at deep cryogenic temperatures (mK).

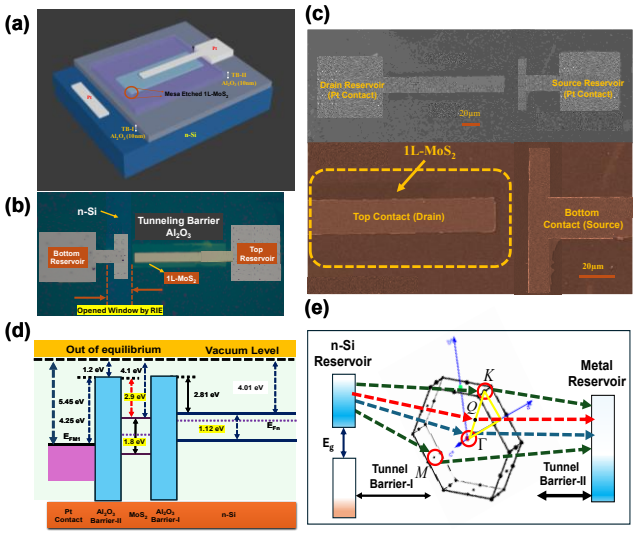

Figure.1: (a) Device Schematic, (b, c) fabricated device, (d, e) band-diagram and transport mechanism, (f) Transport Characteristics

References

[1] Mukherjee, A.; Sharma, K.; Bhatt, K.; Kandar, S.; Singh, R.; Das, S. MBE Grown Tri-Layer 2H-MoTe2 Quantum Wells Coupled with WSe2 Carrier Reservoir for Resonant Tunneling Device Applications. APL Quantum 2025, 2 (4), 046112. https://doi.org/10.1063/5.0296597.