Dual Gate L-Shaped Field-Effect-Transistor for Steep Subthreshold Slope

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ABSTRACT

Dual gate L-shaped tunnel field-effect-transistor (DG-LTFET) is presented in this study. DG-LTFET achieves near vertical subthreshold slope (SS) and its ON current is also found to be higher then both conventional TFET and LTFET. This device could serve as a potential replacement for conventional complimentary metal-oxide-semiconductor (CMOS) technology.

Keywords
dual-gate, BTBT, LTFET, potential

I. Introduction

L-shaped tunnel field-effect transistor (LTFET) has been experimentally reported [1] to exhibit better subtrehshold (SS) and higher ON current Ion then conventional TFETs. In this work, an alternate version of LTFET is presented which can achieve an even lower inverse SS and higher Ion over conventional TFET.

II. Quantum Confinement Effect

Fig. 1(a) shows schematic of LTFET. In LTFET electric field from the gate converges around the sharp source corner resulting in significant corner-effect in the bottom part of the channel. Corner-effect degrades device SS. If instead two gates are used as shown in Fig. 1(b), each gate with a different workfunction then the corner-effect can be overcome which results in significantly improved subthreshold and ON current performance.

III. Results

Dynamic nonlocal band-to-band-tunneling (BTBT) model was used as well as Fermi statistics, and CVT mobility model [2]. Fig. 2 shows results of LTFET compared with DG-LTFET for several workfuntions. As the gate 1 workfunction gets lower the SS becomes steeper.

This is because the lower workfunction of gate 1 forces the top channel to turn on at a lower bias then the lower part of the channel. The BTBT rate in top part of the channel is higher then it is in the lower part. This results in higher current and steeper SS as the workfunction gets lower. Fig. 3 and 4 show BTBT rate at Vgs=0.070 V. They clearly show top of the channel is on (partially) and the bottom part is off.

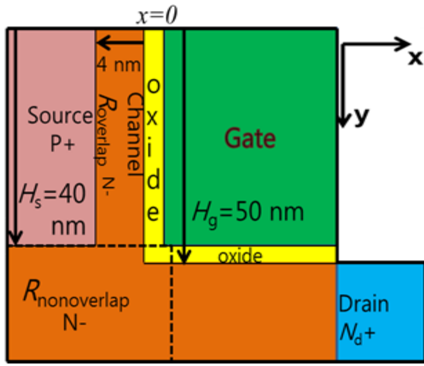
IV. Conclusion

It was found that the DG-LTFET structure exhibits significantly better performance then convnetional LTFET and can be considered as a potential replacement device for current CMOS technology.

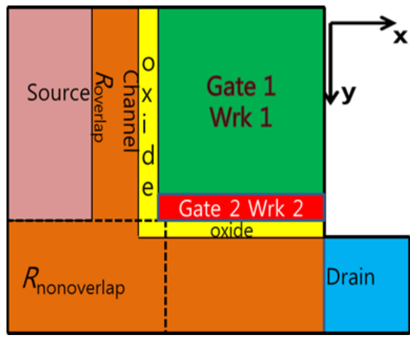
References

[1] S. W. Kim, J. H. Kim, T. J. K. Liu, W. Y. Choi, and B. G. Park, "Demonstration of L-shaped tunnel field-effect transistor," *IEEE Trans. Electron Devices*, vol. 63, no. 4, pp. 1774-1778, Apr. 2016.

[2] Sentaurus User Manual, version L-2016.03, Mar. 2016.



(a)



(b)

Fig. 1 (a) LTFET (b) DG-LTFET.

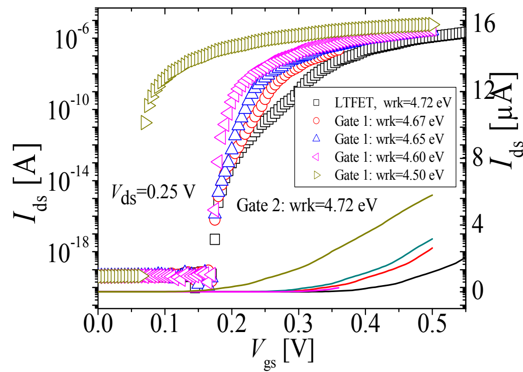


Fig. 2 I_{ds}-V_{gs} of LTFET (line) comapred with I_{ds}-V_{gs} of DG-LTFET (symbols) for several different work-fiunctions.

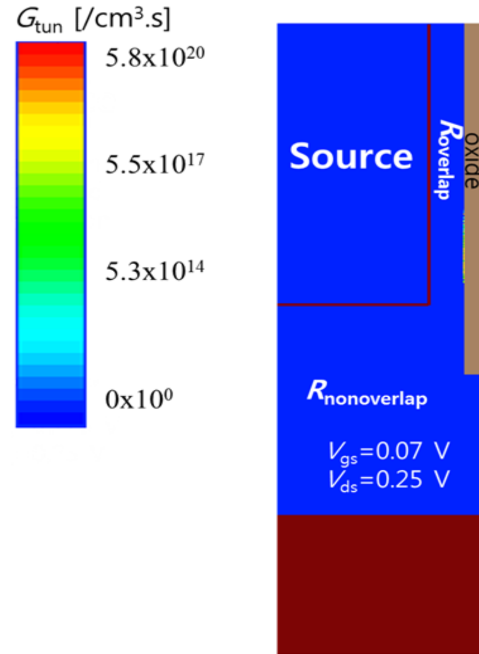


Fig. 3. BTBT rate at V_{gs} = 0.070 V. Top part of the channel is (partially) on whereas the bottom part of the channel is completely switched off.

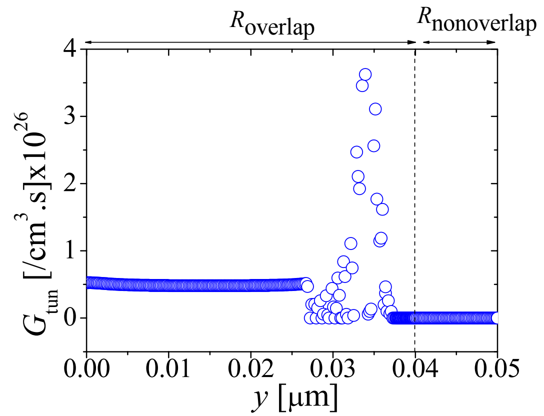


Fig. 4. BTBT rate extracted along the surface showing from Fig. 3. Top part of the channel is on and the bottom part is off.