Statistical Leakage Current Analysis of Trapezoidal Tri-Gate FinFET

A thesis submitted in partial fulfillment of the requirements for the degree of

Bachelor of Science

in

Electrical, Electronic and Communication Engineering

Submitted by

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December, 2014

CERTIFICATION

The thesis titled "**Statistical Leakage Current Analysis of Trapezoidal Tri-Gate FinFET** " submitted by Farhana Afrin, Syeda Sanjidah and Twisha Titirsha has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science In Electrical, Electronic And Communication Engineering on December, 2014.

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DECLARATION

It is hereby declared that the work presented in the thesis titled “Statistical Leakage Current Analysis of Trapezoidal FinFET” is an outcome of the study carried out by the author under the supervision of Dr. Md. Kawsar Alam. It is also declared that neither of this thesis paper nor any part therefore has been submitted anywhere else for the award of any degree, diploma or other qualifications.

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DEDICATION

To Our Beloved Parents

Acknowledgment

We would first like to express our deepest gratitude to our thesis supervisor, Assistant Professor Dr. Md. Kawsar Alam. His consistent encouragement, patient advice, and thorough guidance have been a key for us to accomplish this thesis. His high standards for innovation has always led us to work on the cutting-edge topics and execute them to the best of our abilities. We are thankful to him for giving us the opportunity to work on this topic and his invaluable guidance over the last year. The creative freedom given to us was the essential ingredient in turning this thesis into a successful venture. We are grateful to have him as our thesis supervisor, and are honored to be his thesis group.

We would like to thank our Dean Capt M Mahbubur Rahman,(L),psc,BN, Head of the Department Gp Capt Dr. Mohammed Hossam-e-Haider and Class Coordinator A N M Didarul Alam for their generous advice on our research work. Their insightful suggestions helped us to carry out our work successfully. We would like to thank the faculty of the EECE Department at MIST for assistance they have provided us over the past year. Their numerous guidance and advice have deeply enhanced our chances for completion of thesis.
We would also like to thank our fellow mates for all the support they gave us .

Finally, we wish to thank our parents for their endless love and care. They have always been with us through the difficult times. Without their support and encouragement, this thesis would not have been possible.

Dhaka — Farhana Afrin

December, 2014 — Syeda Sanjidah

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Abstract

Leakage current due to process variation is a major issue for the devices technologies. Low leakage devices are a key enabler for long-life System-on-Chip applications with ultralow-power standby requirements. This thesis focuses on the study and development of statistical characteristics of Trigate trapezoidal FinFETs for the prediction of leakage current variation and its distribution using Monte-Carlo method. This paper propounds a statistical modeling approach for estimating the leakage distribution of trapezoidal shaped FinFETs (Tz-FinFETs) under random dopant fluctuation. The simulations have been performed using MATLAB. The purpose of a statistical leakage estimation tool is to get a specific leakage distribution of a FinFET device based on process inputs such as the mean threshold voltage (V_{Th}) and standard deviation of V_{Th} due to process parameter variation. The analysis consists of generating RDF in each fin of a multifin device which leads to an investigation of the impact of RDF on device characteristic and device evaluation. The width-dependent device leakage under atomistic random dopant fluctuation for Tri- gate FinFET could not be accurately modeled by conventional square-root approach. This thesis proposes a statistical leakage model which leads to a significant improvement of the leakage estimation. A comparative study of leakage current distribution of trapezoidal and rectangular FinFET reveals the advantages of trapezoidal FinFETs over rectangular FinFETs. We have also incorporated the effect of fin shape on leakage current. Leakage due to Short Chanel Effects(SCE) decreases as fin widths decreases. Statistical leakage currents due to process variation have been simulated for rectangular shape FinFETs (Re FinFETs) and triangular shape FinFET to compare their performance. Leakage Current increases in silicon on insulator FinFETs as the fin cross-sectional shape changes from rectangular to triangular to trapezoidal. The triangular and trapezoidal shape FinFET has better performance i.e low leakage current over conventional rectangular shape FinFET. Additionally this paper demonstrates the effect of number of fins on leakage current.

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V_{Th}	Threshold Voltage
W_{fin}	Fin Width
T_{si}	Body Thickness
H_{fin}	Fin Height
T_{fin}	Fin Thickness
S_{fin}	Fin Spacing
I_{ON}	On Current
I_{OFF}	Off Current
V_T	Thermal Voltage
σV_{th}	Standard deviation of Threshold Voltage
V_{FB}	Flatband voltage
N_{si}	Doping concentration
n_i	Intrinsic carrier concentration
C_g	Gate Oxide Capacitance Per Unit Length
C_{ch}	Channel Capacitance Per Unit Length
Q_d	Depletion Charge Per Unit Length
W_{eff}	Effective Width
T_{ox}	Oxide Thickness
ε_{ox}	Relative Permittivity Of The Oxide
L_{eff}	Effective Length
$\mu(V_{Th})$	Mean Threshold Voltage
n	Number of Fins
ε_{si}	Relative permittivity of the Silicon