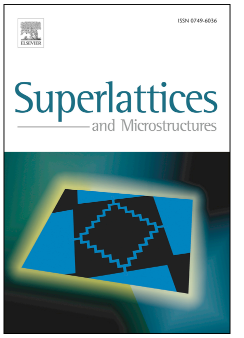
Accepted Manuscript



Two dimensional analytical model for a reconfigurable field effect transistors

R. Ranjith, Remya Jayachandran, K.J. Suja, Rama S. Komaragiri

PII: S0749-6036(17)31841-4

DOI: 10.1016/j.spmi.2017.12.006

Reference: YSPMI 5403

To appear in: *Superlattices and Microstructures*

Received Date: 2 August 2017

Revised Date: 2 December 2017

Accepted Date: 4 December 2017

Two Dimensional Analytical Model for a Reconfigurable Field Effect Transistors

Ranjith R.[a], Remya Jayachandran[a], Suja K. J.[a], Rama S. Komaragiri[b]

[a]*Department of Electronics and Communication Engineering*
National Institute of Technology Calicut, Kozhikode, India
Email:ranjith_p120097ec@nitc.ac.in
[b]*Department of Electronics and Communication Engineering*
Bennett University, Greater Noida, India
Email: rama.komaragiri@bennett.edu.in

Abstract

This paper presents two-dimensional potential and current models for a reconfigurable field effect transistor (RFET). Two potential models which describe subthreshold and above-threshold channel potentials are developed by solving two-dimensional (2D) Poisson's equation. In the first potential model, 2D Poisson's equation is solved by considering constant/zero charge density in the channel region of the device to get the subthreshold potential characteristics. In the second model, accumulation charge density is considered to get above-threshold potential characteristics of the device. The proposed models are applicable for the device having lightly doped or intrinsic channel. While obtaining the mathematical model, whole body area is divided into two regions: gated region and un-gated region. The analytical models are compared with technology computer-aided design (TCAD) simulation results and are in complete agreement for different lengths of the gated regions as well as at various supply voltage levels.

Keywords:
Reconfigurable field effect transistor, analytical modelling, Poisson's equation, simulations, high-κ dielectric, inverter.

1. Introduction

Reconfigurable field effect transistors (RFETs) are the devices which provide both n-type and p-type characteristics depending on the electrical bias applied to the terminals of the device. Due to the programmable behaviour, RFETs offer a distinct advantage in the field of programmable logic arrays (PLAs) [1, 2]. Different applications of RFETs are discussed in [3–6]. If a device is reconfigurable, it is possible to reduce the number of transistors to implement a logic function to a great extent. Recently, many structures of RFET are introduced in the literature [7–13]. These structures utilise channel materials such as graphene [7], carbon nanotubes (CNTs) [8] and intrinsic or lightly doped silicon (Si) [9–13]. In all these works, conventional semiconductor ohmic source/drain (S/D) are replaced by Schottky metal S/D.

In [13], a simplified and yet advantageous RFET device structure is proposed. The structure is a short gated Si nanowire field effect transistor (SiNWFET). In this structure, the gate is placed near to metal S/D–semiconductor junction. Different combinations of gate and drain biases are used to switch the device from n-type to p-type. In our work, a device having a significant difference of multi-gate structure, relating to the structure presented in [13] is considered. In other words, a two dimensional (2D) RFET device having similar cross section of RFET in [13] is modelled in this work. Analytical expressions for potential and current of the device are derived and then validated using 2D TCAD simulations. Simulated three-dimensional RFET structure, its cross-sectional view and the calibrated current-voltage characteristics are shown in Fig. 1(a), 1(b) and 1(c) respectively.