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REGULAR PAPER

Dopingless Extended Source TFET for Switching and Analog/RF Applications

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Abstract
A doping-less extended source tunnel FET (DLES-TFET) is proposed for low power switching and analog/RF applications. In the proposed structure, the source metal is extended into the intrinsic Si-channel to form p+-source using charge plasma. An n+-drain is created by inducing electrons from drain metal to intrinsic Si-channel. Further, the gate metal in DLES- TFET is extended towards drain to obtain a field plate structure which improves the performance of proposed device. The performance of the proposed DLES-TFET is investigated using 2D simulations in TCAD tool (ATLAS). Our simulation results reveal that the DLES-TFET achieves high I_{ON} /I_{OFF} of 2.86×10^{13}, low subthreshold swing of 1.5 mV/dec and low threshold voltage of 0.24 V. Additionally, suggested device attains a peak transconductance of 115 µS/µm, cut-off frequency of 33.3 GHz, and offers a gain bandwidth product of 15.2 GHz.

Keywords Dopingless · Charge plasma · Band to band tunnelling (BTBT) · Tunnel FET · Subthreshold swing

1 Introduction

The tunnel field effect transistors (TFETs) are gaining importance due to extremely low subthreshold swing (SS), low OFF-state current (I_{OFF}) and elimination of short channel effects (SCEs) as compared to conventional MOSFETs [1]. However, the insufficient band to band tunnelling (BTBT) in conventional TFETs results in low ON-state current (I_{ON}). In order to overcome this problem, several TFET structures have been proposed in literature [2–5]. Further, the continuously down-scaled TFETs suffers from random dopant fluctuations (RDFs) leading to large increase in I_{OFF} [6, 7]. Moreover, abrupt drain/channel and source/channel junctions are essential in TFETs to achieve sufficient BTBT. However, realizing abrupt junctions using high temperature process is not easy due to diffusion of dopant atoms from source and drain regions to the channel [6, 7]. To address these issues, doping-less charge plasma based TFETs have been reported in the literature [6–15]. However, these doping-less TFETs exhibit limited ION as in case of conventional surface tunnelling FETs.

In the past, an appreciable improvement in I_{ON} of TFETs have been achieved using gate overlapped source (GoS) structures in which the source is extended into the channel region enabling line as well as point tunnelling [3, 16, 17]. To the best of author's knowledge, a doping-less extended source TFET structure has not been reported in the literature. Therefore, for the first time, we propose a charge plasma based doping-less extended source (DLES) TFET structure. The performance of DLES-TFET is evaluated using 2D numerical simulations in a commercially available TCAD tool (ATLAS) [18]. The proposed DLES-TFET achieves an I_{ON} /I_{OFF} of 2.86×10^{13}, SS of 1.5 mV/dec and V_t of 0.24 V. The GoS TFET structures have been proposed to increase

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