Mixde-mode simulation을 이용한 4H-SiC DMOSFETs의 계면상태에서 포획된 전하에 따른 transient 특성 분석

강민석[1], 최창용[1], 방욱[2], 김상철[2], 김남균[2], 구상모[1*]
광운대학교[1], 한국전기연구원[2]

Mixed-mode simulation of transient characteristics of 4H-SiC DMOSFETs - Impact off the interface charges

Min-Seok Kang[1], Wook Bang[2], Sang-Chul Kim[2], Nam-Kyun Kim[2], Sang-Mo Koo[1*]
Kwangwoon Univ.[1], Korea Electrotechnology Research Institute (KERI)[2]
*Corresponding Author : smkoo@kw.ac.kr

Abstract : Silicon Carbide (SiC) is a material with a wide bandgap (3.26eV), a high critical electric field (~2.3MV/cm), a and a high bulk electron mobility (~900cm^2/Vs). These electronic properties allow high breakdown voltage, high frequency, and high temperature operation compared to Silicon devices. Although various SiC DMOSFET structures have been reported so far for optimizing performances, the effect of channel dimension on the switching performance of SiC DMOSFETs has not been extensively examined.

In this paper, we report the effect of the interface states (Q_S) on the transient characteristics of SiC DMOSFETs. The key design parameters for SiC DMOSFETs have been optimized and a physics-based two-dimensional (2-D) mixed device and circuit simulator by Silvaco Inc. has been used to understand the relationship with the switching characteristics. To investigate transient characteristic of the device, mixed-mode simulation has been performed, where the solution of the basic transport equations for the 2-D device structures is directly embedded into the solution procedure for the circuit equations. The result is a low-loss transient characteristic at low Q_S. Based on the simulation results, the DMOSFETs exhibit the turn-on time of 10ns at short channel and 9ns at without the interface charges. By reducing SiO_2/SiC interface charge, power losses and switching time also decreases, primarily due to the lowered channel mobilities. As high density interface states can result in increased carrier trapping, or recombination centers or scattering sites. Therefore, the quality of SiO_2/SiC interfaces is important for both static and transient properties of SiC MOSFET devices.

Key Words : Silicon carbide, Transient, Interface charge, DMOSFET

감사의 글

본 논문은 산업자원부가 지원하는 국가 반도체연구사업인 "시스템 집적반도체기반기술개발사업 (시스템IC2010)"을 통해 개발된 결과임을 밝힙니다.