Chapter 1: Introduction

BSIMSOI is an international standard model for SOI (Silicon-On-Insulator) circuit design [20, 21]. This model is formulated on top of the BSIM3 framework [1]. It shares the same basic equations with the bulk model so that the physical nature and smoothness of BSIM3v3 are retained. Most parameters related to general MOSFET operation (non-SOI specific) are directly imported from BSIM3v3 to ensure parameter compatibility.

BSIMPD [18] is the Partial-Depletion (PD) mode of BSIMSOI. Many enhanced features are included in BSIMPD through the joint effort of the BSIM Team at UC Berkeley and IBM Semiconductor Research and Development Center (SRDC) at East Fishkill. In particular, the model has been tested extensively within IBM on its state-of-the-art high speed SOI technology.

BSIMPD, a derivative of BSIM3SOIv1.3 [2], has the following features and enhancements:

- Real floating body simulation in both I-V and C-V. The body potential is determined by the balance of all the body current components.
- An improved parasitic bipolar current model. This includes enhancements in the various diode leakage components, second order effects (high-level injection and Early effect), diffusion charge equation, and temperature dependence of the diode junction capacitance.
- An improved impact-ionization current model. The contribution from BJT current is also modeled by the parameter *Fbjtii*.
- A gate-to-body tunneling current model, which is important to thin-oxide SOI technologies.
- Enhancements in the threshold voltage and bulk charge formulation of the high positive body bias regime.
- Instance parameters (*Pdbcp, Psbcp, Agbcp, Aebcp, Nbc*) are provided to model the parasitics of devices with various body-contact and isolation structures [17].

- An external body node (the 6th node) and other improvements are introduced to facilitate the modeling of distributed body-resistance [17].
- Self heating. An external temperature node (the 7th node) is supported to facilitate the simulation of thermal coupling among neighboring devices.
- A unique SOI low frequency noise model, including a new excess noise resulting from the floating body effect [3].
- Width dependence of the body effect is modeled by parameters (*K1*, *K1w1*, *K1w2*).
- Improved history dependence of the body charges with two new parameters, (*Fbody*, *DLCB*).
- An instance parameter *Vbsusr* is provided for users to set the transient initial condition of the body potential.
- The new charge-thickness capacitance model introduced in BSIM3v3.2 [4], capMod=3, is included.

In BSIMSOI4.0, based on BSIMSOI3.2 [26] and BSIM4.5.0 bulk model [27], we included the following features:

1. A scalable stress effect model for process induced stress effect, device performance becoming thus a function of the active area geometry and the location of the device in the active area;
2. Asymmetric current/capacitance model S/D diode and asymmetric S/D resistance;
3. Improved GIDL model with BSIM4 GIDL compatibility;
4. Noise model Improvements;
   1) Improved width/length dependence on flicker noise
   2) SPICE2 thermal noise model is introduced as TNOIMOD=2 with parameter NTNOI that adjusts the magnitude of the noise density
   3) Body contact resistance induced thermal noise
   4) Thermal noise induced by the body resistance network
   5) Shot noises induced by Ibs and Ibd separated
5. A two resistance body resistance network introduced for RF simulation;
6. Threshold voltage model enhancement;

1) Long channel DIBL effect model added

2) Channel-length dependence of body effect improved

7. Drain induced threshold shift(DITS) model introduced in output conductance;

8. Improved model accuracy in moderate inversion region with BSIM4 compatible Vgsteff;

9. Multi-finger device with instance parameter NF;

10. An new instance parameter AGBCPD to improve gate current for body contact;

11. A new instance parameter DELVTO representing threshold voltage variation;

12. FRBODY is both instance/model parameter