The Bipolar Field-Effect Transistor Theory*,**

(B. Latest Advances)

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Abstract

Latest advances are presented on theoretical device and circuit characterizations of the Bipolar Field-effect transistor (BiFET) [1]. The 2-Dimensional (2-D) rectangular geometry of the transistor (uniform in the width direction) is employed to separate the 2-D equations into two surface-electric-potential-coupled 1-D equations, enabling generic baseline solutions, without 2-D features which are then treated as modifications of the 1-D solutions. The 1952-Shockley 2-section volume-channel geometry model of Junction-Gate (JG) FET is applied to the surface-and-volume-channels of the MOS BiFET, designated as an emitter and a collector sections, each can simultaneously have electron and hole, surface or volume channels. The exactly identical (near thermal equilibrium, no hot carriers) electrochemical potential (ECP or quasi-Fermi potential) and drift-diffusion (DD) approaches are employed. Numerical results are readily obtained for the analytical ECP, but tedious for the DD theory requiring analytical approximations. Asymptotic approach to 1-Gate from 2-Gate, and from impure-Base to pure-Base are illustrated. Deviations of DD theory from ECP theory are demonstrated. Two-Dimensional geometric effects near intersections of the four electrodes (Gate 1, Gate 2, Source and Drain) are described. DC characteristics are computed and presented for both the traditional transistor device and also the basic-building-block (BBB [2]) circuit function configurations.

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References

[1] See references given in Bin B. Jie and Chih-Tang Sah, "The Bipolar Field-Effect Transistor Theory (A. Summary of Recent Progresses.)." Preceding paper, this conference.

[2] Chih-Tang Sah, *Fundamentals of Solid-State Electronics*, World Scientific Publishing Company, 1991. See sections 670 to 674 on pages 596 to 643 on Circuit Applications of MOSFET for the Basic-Building-Block (BBB) circuits (DRAM, NMOS-CMOS inverters, SRAM, Nonvolatile-RAM).