A SINGULAR PERTURBATION ANALYSIS
OF THE FUNDAMENTAL SEMICONDUCTOR
DEVICE EQUATIONS - ANALYSIS AND
NUMERICAL EXPERIMENTS

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Abstract

In this paper we present a singular perturbation analysis of the
fundamental semiconductor device equations which form a system of
three second order elliptic differential equations subject to mixed
Neumann-Dirichlet boundary conditions. The system consists of Poisson's
equation and the continuity equations and describes potential and
carrier distributions in semiconductor device

The singular perturbation parameter is the minimal Debye-length of
the device under consideration.

Using matched asymptotic expansions we demonstrate the occurrence
of internal layers at surfaces across which the impurity distribution
(which appears as an inhomogeneity of Poisson's equation) has a jump-
discontinuity (these surfaces are called 'junctions') and the occurrence
of boundary layers at semiconductor-oxide interfaces. We derive the
layer-equations and the reduced problem (charge-neutral-approximation).
The layer solutions which characterize the solution of the singularly
perturbed problem close to junctions and interfaces resp. decay ex-
ponentially away from the junctions and interfaces resp.
Numerical results obtained by the aid of the singular perturbation
analysis are presented.