'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 occurance of internal layers at surfaces across which the impurity distribution (which appears as an inhomogeneity of Poisson's equation) has a jump-discontiniuity (these surfaces are called 'junctions') and the occurance 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 exponentially away from the junctions and interfaces resp.
Numerical results obtained by the aid of the singular perturbation analysis are presented.