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Nanodevices for Terahertz

Dr. D. K. Ferry

Department of Electrical Engineering, Arizona State University, Tempe 85287 USA
ferry@asu.edu, www.fulton.asu.edu/~ferry

High-electron mobility transistors (HEMTs) have become an important device for high frequency and low noise applications. The performance of these devices has been pushed into the range of several hundred GHz for f_T. One question that has been asked is just how high a frequency can be obtained with these devices. To study this question, we have used a full-band, cellular Monte Carlo transport program, coupled to a full Poisson solver to study a variety of HEMTs and their response at high frequency. In this approach, the band structure of the strained material is determined from an empirical pseudopotential approach, including non-local and spin-orbit interactions, and the transport is then determined via a cellular Monte Carlo technique. In this approach, the phonon dynamics are determined via a valence shell model, and the electron-phonon interactions determined by first-principles, except for the Coulombic impurity and non-polar interactions. We have concentrated on pseudomorphic HEMTs with the structure (from the substrate) InP/InAlAs/InGaAs/InAlAs/InGaAs, with the quantum well composed of $In_{0.75}Ga_{0.25}As$, and have studied gate lengths over the range 10-50 nm. Various source-drain spacings have also been studied, and the performance of scaled devices evaluated to determine the ultimate frequency limit. Here, the importance of the effective gate length has been evaluated from the properties internal to the device. This allows the estimation of the limit from the extension to the case of a vanishing physical gate length. We will also discuss high power devices based upon GaN, and the scaling that can be applied to such devices.