New Physics of Electron Transport in Nitrides

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The physics of the electron transport in AlN/GaN/InN-based semiconductors materials is different from that for more conventional semiconductors, such as Si or GaAs. In wide band gap semiconductors, such as nitrides and SiC, the polar optical phonon energy is large (much larger than the thermal energy at room temperature. As a consequence, in low electric fields, the dominant optical polar scattering occurs in two steps – photon absorption and re-emission resulting in an elastic scattering process. [1] In high electric fields, an electron runaway plays a key role determining the peak field and peak velocity in these compounds. [2] The runaway effects are further enhanced in two dimensional electron gas at the AlGaN/GaN or AlGaInN/InGaN heterointerfaces. As a result, the peak electron drift velocity and peak electric field of the 2D electrons in compound semiconductors are smaller than the 3D electrons in these materials. [3] This prediction agrees with the results of Monte-Carlo simulations and with the measured peak velocities. In very short (e.g. sub-0.1 micron) GaN structures, ballistic and overshoot effects become important. [4] We will discuss the consequences of these effects for deep submicron AlGaInN/GaN filed effect transistors. We will also review the results of recent magnetotransport measurements that allow us to establish the band structure parameters of GaN. [5]

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