Hot phonons and electrons in hot GaN based heterojunction field effect transistors

Hadis Morkoç

Department of Electrical and Computer Engineering
Virginia Commonwealth University
Richmond, VA 23284

Semiconductor GaN is getting considerable traction because of device applications of devices to energy efficient LED lighting, back illumination in consumer electronics including flat panel and energy efficient TVs, short wavelength lasers, high RF power, and high power switching applications particularly with the advent of nontraditional local power generation/distribution, and hybrid and all electric vehicles. In many of these devices, electrons during operation get accelerated to high kinetic energies that they are not in thermal equilibrium with the lattice (hot electrons) which is standard in all semiconductors in this operating realm. However, what is unique to GaN is the very strong electron phonon coupling which leads to population of LO phonons which are not in equilibrium with the lattice temperature (hot phonons). Unless they decay to LA phonons very rapidly, which they do not, they retain heat as well as scattering electrons, with adverse effect on performance, owing to their low group velocity and concentration in a small volume in the k-space (phonon bottleneck). In this presentation, the hot phonons and their lifetime *vis-a-vis* the electron concentration and electric field will be discussed along with their impact on device performance.

Hadis Morkoç received his education at Istanbul Technical University (Turkey) and Cornell University following which he held positions in industry and academia before joining VCU School of Engineering during the establishment phase. His research activity has been at the confluence of semiconductor device physics and semiconductor physics with many journal articles, book chapters, review and popular articles on semiconductor heterostructures and devices, and books on MODFETs, nanostructures, and Nitride Semiconductors and Devices, ZnO and Devices, and 3-volume handbook on nitride semiconductors. He is one of the highest cited authors in that areas of engineering, physics, and material science.