

GaN-Based HEMTs for High Voltage Operation: Design, Technology and Characterization



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Cuvillier Verlag Jun 2012, 2012. Taschenbuch. Book Condition: Neu. 208x147x14 mm. Neuware - Gallium nitride (GaN)-based High Electron Mobility Transistors (HEMTs) for high voltage, high power switching and regulating for space applications are studied in this work. Efficient power switching is associated with operation in high OFF-state blocking voltage while keeping the ON-state resistance, the dynamic dispersion and leakage currents as low as possible. The potential of such devices to operate at high voltages is limited by a chain of factors such as subthreshold leakages and the device geometry. Blocking voltage enhancement is a complicated problem that requires parallel methods for solution; epitaxial layers design, device structural and geometry design, and suitable semiconductor manufacturing technique. In this work physical-based device simulation as an engineering tool was developed. An overview on GaN-based HEMTs physical based device simulation using Silvaco-ATLAS is given. The simulation is utilized to analyze, give insight to the modes of operation of the device and for design and evaluation of innovative concepts. Physical-based models that describe the properties of the semiconductor material are introduced. A detailed description of the specific AlGaIn/GaN HEMT structure definition and geometries are given along with the complex fine meshing requirements. Nitride-semiconductor specific material properties and their physical models are reviewed focusing on the energetic band structure, epitaxial strain tensor calculation in wurtzite materials and build-in polarization models. Special attention for thermal conductivity, carriers' mobility and Schottky-gate-reverse-bias-tunneling is paid. Empirical parameters matching and adjustment of models parameters to match the experimental device measured results are discussed. An enhancement of breakdown voltage in Al_xGa_{1-x}N/GaN HEMT devices by increasing the electron confinement in the transistor channel using a low Al content Al_yGa_{1-y}N back-barrier layer structure is systematically studied. It is shown that the reduced sub-threshold drain-leakage current through the buffer layer postpones the punch-through and therefore...



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