Inverse Design of AlGaN/GaN HEMT RF Device with Source Connected Field Plate

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Abstract

This study introduces a novel approach in the prediction, design, and optimization of Breakdown Voltage (BV) and Leakage Current in AlGaN/GaN High Electron Mobility Transistors (HEMTs) with a source-connected field plate (SCFP) using an Artificial Neural Network (ANN) model. For the first time, the concept of inverse design is applied to the HEMT structures, enabling the accurate prediction of structural parameters from key performance metrics. Additionally, a novel method for predicting current collapse based on the peak electric field in the access region is proposed, offering a faster alternative to traditional pulsed DC analysis. The electrical performance of the reference device is optimized through a unique approach that combines a genetic algorithm with the ANN model, incorporating data augmentation to ensure high accuracy. The ANN demonstrated exceptional precision, achieving an R2 score of 99% and an error rate below 1%. To validate the model's predictions, TCAD simulations were performed on the Pareto-optimal solutions, yielding a minimum error rate of 1.67%. This work marks a significant step forward in applying machine learning to AlGaN/GaN HEMT device design, offering a novel, efficient alternative to traditional simulation methods and paving the way for a more energy-efficient device design process.

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