

Abstract

In the research, an attempt has been carried out to address various significant technological hurdles for implementing epitaxial nitride based HEMT on silicon for RF switch application. The extent of this research is from fabrication level to circuit simulation in EDA tool by incorporating VerilogA model, via parameter extraction. The present study demonstrates various approaches to overcome the issues namely circuit simulation via device data, an alternate method for parameter extraction of the small signal model and the impact of material property on the contact resistance. All of these have been done by utilizing the moderate and new laboratory infrastructure. Therefore, the investigation has been divided into three parts namely simulation, modelling and fabrication/characterization.

The modelling part consists of incorporation of device data (experimental and simulation) in EDA tool for RF switch simulation. Another way for SSM parameter extraction has been established through machine learning system like ANN and SVM. This methodology can be extended further for any critical RF device. On the other hand, an impact of R_{ON} on the performance parameters (i.e., insertion loss and isolation) of the RF switch has been visualized for the academic purpose. The origin of the source resistance has been explored through the fabrication. The Au/Cr based TLM pattern has been formed by creating the mask and implementing optical lithography via mask aligner for wet etching and FIB for dry etching.

The preliminary characterizations of elemental composition and roughness of the etched MBE grown samples have been scrutinized through AES, FESEM and AFM. The utilization of Keithley's 4200 SCS is done for measuring the contact resistance. Low resistance Au/Cr ($6.254 \Omega.mm$) ohmic contacts have been established on the Ga-polar surface, whereas, the N-polar surface shows $32.539 \Omega.mm$ on the GaN surface. The polarity of the surface has been examined via molten KOH-based etching and AES. Comparison between two types of GaN etching techniques has been made, based on surface morphology and topography. Results show dry etching is the better way than wet etching process. The present work may help RF switch designers to expand their scope of options for confronting issues related to the material to the circuit via the device.

Keywords: GaN, Ga and N polar, HEMT, VerilogA model, parameter extraction, ANN, SVM, RF switch, etching, FIB lithography, contact resistance, MBE.