# Resum de Tesi Doctoral

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola de Doctorat

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| Títol de la tesi | Advanced AlGaN/GaN HEMT technology, design, fabrication and characterization |
| Unitat estructural | Departement d'Enginyeria Electrònica |
| Programa | En Enginyeria Electrònica |
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(Mínim 1 i màxim 4, podeu veure els codis a http://doctorat.upc.edu/gestio-academica/impresos/tesi-matricula-i-diposit/codis-unesco)

Resum de la tesi de 4000 caràcters màxim (si supera els 4000 es tallarà automàticament)


Nowadays, the microelectronics technology is based on the mature and very well established silicon (Si) technology. However, Si exhibits some important limitations regarding its voltage blocking capability, operation temperature and switching frequency. In this sense, Gallium Nitride (GaN)-based high electron mobility transistors (HEMTs) devices have the potential to make this change possible. The unique combination of the high-breakdown field, the high-channel electron mobility of the two dimensional electron gas (2DEG), and high-temperature of operation has attracted enormous interest from social, academia and industry and in this context this PhD dissertation has been made. This thesis has focused on improving the device performance through the advanced design, fabrication and characterization of AlGaN/GaN HEMTs, primarily grown on Si templates.

The first milestone of this PhD dissertation has been the establishment of a know-how on GaN HEMT technology from several points of view: the device design, the device modeling, the process fabrication and the advanced characterization primarily using devices fabricated at Centre de Recherche sur l'Hétéro-Epitaxie (CRHEA-CNRS) (France) in the framework of a collaborative project. In this project, the main workhorse of this dissertation was the explorative analysis performed on the AlGaN/GaN HEMTs by innovative electrical and physical characterization methods. A relevant objective of this thesis was also to merge the nanotechnology approach with the conventional characterization techniques at the device scale to understand the device performance.

A number of physical characterization techniques have been imaginatively used during this PhD determine the main physical parameters of our devices such as the morphology, the composition, the threading dislocations density, the nanoscale conductive pattern and others. The conductive atomic force microscopy (CAFM) tool have been widely described and used to understand the conduction mechanisms through the AlGaN/GaN Ohmic contact by performing simultaneously topography and electrical conductivity measurements. As it occurs with the most of the electronic switches, the gate stack is maybe the critical part of the device in terms of performance and longtime reliability. For this reason, how the AlGaN/GaN HEMT gate contact affects the overall HEMT behaviour by means of advanced characterization and modeling has been intensively investigated.

It is worth mentioning that the high-temperature characterization is also a cornerstone of this PhD. It has been reported the elevated temperature impact on the forward and the reverse leakage currents for analogous Schottky gate HEMTs grown on different substrates: Si, sapphire and free-standing GaN (FS-GaN). The HEMT' forward-current temperature coefficients (T^α) as well as the thermal activation energies have been determined in the range of 25-300 ºC. Besides, the impact of the elevated temperature on the Ohmic and gate contacts has also been investigated.

The main results of the gold-free AlGaN/GaN HEMTs high-voltage devices fabricated with a 4 inch Si CMOS compatible technology at the clean room of the CNM in the framework of the industrial contract with ON semiconductor were presented. We have shown that the fabricated devices are in the state-of-the-art (gold-free Ohmic and Schottky contacts) taking into account their power device figure-of-merit ((VB^2)/Ron) of 4.05×10^8 W/cm^2. Basically, two different families of AlGaN/GaN-on-Si MIS-HEMTs devices were fabricated on commercial 4 inch wafers: (i) using a thin ALD HfO2 (deposited on the CNM clean room) and (ii) thin in-situ grown Si3N4, as a gate insulator (grown by the vendor). The scientific impact of this PhD in terms of science indicators is of 17 journal papers (8 as first author) and 10 contributions at international conferences.


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