PhD School in Information and Communication Technologies (ICT)

Research project for the PhD curriculum "Industrial applications of ICT"
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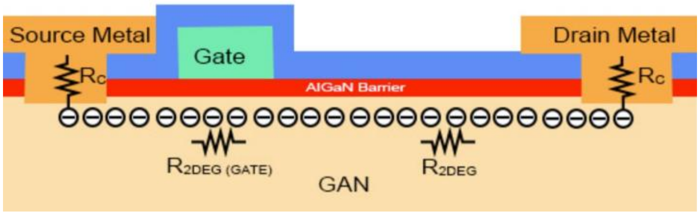
Title of the research: Device to Circuit Modelling and simulation of Gallium Nitride power devices based on Monte Carlo methodologies

Keywords:
Power Electronics
GaN
Monte Carlo methods
Simulation
Device and circuit modelling



Research objectives:

Gallium Nitride (GaN) is a compound semiconductor with a large breakdown field and high electron velocity. These properties, together with the possibility to integrate GaN on silicon substrates, make it a material of choice for the fabrication of power devices, opening the possibility to realize power converters with high efficiency and small volume, as needed for the green transition.Modelling and simulation play a pivotal role in improving the design of the GaN power devices and in understanding the outcome of the experiments carried out in semiconductor companies and in academia.
Commercial software for device simulation already includes some modelling ingredients to evaluate the performance of GaN power devices, but they still lack accurate models for the effect of high energy electrons, as those responsible for the device degradation and for dynamic effect such as the dispersion in the ON-resistance (that negatively affects the efficiency of power converters).

Proposed research activity
The aim of the research is to develop modelling tools based on the Monte Carlo approach to analyse hot electron effects inside GaN power HEMTs and leading, among others, to ON-resistance dispersion. The simulator will be aligned with the state of the art and include the main mechanisms contributing to the energy gain/loss by the electrons inside the device, including unexplored mechanisms of carrier trapping detrapping involving hot electrons. The candidate will enjoy the long standing experience of the hosting research group at UniMORE in the development of Monte Carlo simulation techniques and tools for a large variety of electron devices and sensors.
Collaboration with an industrial partner, world leader in advanced GaN technology, and with Italian and European research groups, will give to the candidate the unique opportunity to discuss ideas and receive experimental data on realistic devices. The development of the Monte Carlo simulator would give the candidate the opportunity to improve his/her know-how in numerical model, multiscale modelling and in materials' physics. The activities include spending a significant fraction of time in using the model to interpret experimental data and optimize the device structure to improve the transistor immunity to hot-electron phenomena.

Supporting research projects (and Department)
The activity will be carried out mostly at the DIEF, Università degli studi di Modena e Reggio Emilia

Possible connections with research groups, companies, universities.
Infineon Technologies Austria
IUNET Research Consortium (IT - www.iunet.info)