SUSTAINABLE MATERIALS, PROCESSES AND SYSTEMS FOR ENERGY TRANSITION

DM 630/Applied Materials Italia - Material to device simulations accounting for quantum effects and material imperfection for novel technology nodes

Funded By	APPLIED MATERIALS ITALIA S.R.L. [P.iva/CF:00766780266] MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	GaN technology is emerging as a key enabling technology for the development of future generation power devices. On the other hand, GaN devices differ significantly from silicon and silicon carbide devices, making the development of ad hoc modelling tools important. The research will address the modelling needs to optimize power GaN devices, with particular focus on GaN HEMTs. Project funded by Applied Materials Italia Progetto finanziato dal PNRR a valere sul DM 630/2024 – CUP: E14D24002340004
	GaN technology is emerging as a key enabling technology for the development of future generation of power devices. GaN power HEMTs have been recently commercialized with the voltage classes from 15 to 900 V, and they are seeing rapid adoption in power supplies, data centers, Lidar systems, and fast chargers in consumer electronics. GaN based power devices offer advantages in terms of weight, power handling capabilities, thermal management and compatibility with RF and/or digital devices. On the other hand, they differ significantly from the more conventional ones based on silicon and silicon carbide, making the development of ad hoc modelling tools important. The research will address the modelling needs to analyze and optimize GaN devices for power applications, with particular focus on GaN HEMTs.

Objectives	Physics-based simulations will be extensively used to provide a pathway to model GaN devices, from the analysis of the device structure to the nonlinear electrical simulations. Hence, the device performances will be directly related to the underlying fabrication process and material properties. The project leverages on the simulation tools available from AMAT ITALIA and Politecnico di Torino, that will be integrated synergically. AMAT has a deep expertise in the analysis of material defects, including interface and contact imperfections. These techniques will be further developed for power GaN devices, including HEMTs with alternative gate stacks, to identify the most promising solutions in terms of device robustness and speed. Traps will also be specifically addressed in the PhD thesis, to extract the dynamic device bahavior. POLITECNICO will provide its expertise in the analysis on the nonlinear electrical device behavior: the available simulations will be further developed both in the frequency and in the time domain.

Skills and competencies for the development of the activity	Basic knowledge of semiconductor physics and semiconductor devices. Basic knowledge of physics-based numerical simulations, e.g. Sentaurus Synopsys.