Centre de Nanosciences et de Nanotechnologies

Soutenance de thèse

Lundi 29 novembre
10h30
Centre de Nanosciences et de Nanotechnologies
10 boulevard Thomas Gobert
91120 Palaiseau
Amphithéâtre

Yassine OUSSAITI

“Modeling and simulation of the electrical behavior and the quench effciency of Single-Photon Avalanche Diodes”

Jury members :

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Abstract :

The development of numerical methods to simulate the electrical behavior and the quench efficiency in SPADs allows guiding the technological improvement of these photodiodes. For this purpose, standard TCAD solvers are often based on deterministic models and carriers are studied in terms of densities, which affects the estimation of the statistical response for a single photon. Therefore, this Ph.D. work aims to improve the simulation of silicon SPADs, focusing on the avalanche dynamics and its quenching description. To achieve this goal, we investigate various device architectures and analyze the main involved physical mechanisms. Furthermore, we assess certain technology trials to enhance the relevant figures of merit and establish the scaling laws. Importantly, a Verilog-A model accounting for the temporal current build-up and its statistics is presented. This physics-based model enables SPICE simulations of circuits and compares favorably with TCAD mixed-mode predictions. Finally, Monte Carlo algorithms are used to compute the photon detection efficiency and the timing response of SPADs. These results correlated with experiments confirm the method’s accuracy, which can be used for modeling future generations of these photonic devices.