



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 2 - Electronics

**PNRR 117 Research Field: ADVANCED SIMULATION TOOLS FOR THE OPTIMIZATION OF
NEXT GENERATION OF POWER SEMICONDUCTOR DEVICES**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

The demand for power semiconductor devices is forecasted to continue to increase rapidly over the coming years, driving improvements in the technology and subsequent investment in production capacity. Power devices are employed in many applications like motor drives, wind turbines, photovoltaics, trains, UPS, electric vehicles, and home appliances.

The development of innovative power devices is strongly supported by modeling and simulation activities, that enable device engineers to make virtual changes in operating conditions, device design, or semiconductor technology during the development. Models are then refined on the basis of a thorough comparison against experimental data, that allows to build a qualitative and then quantitative understanding of the target power device under development, leading to an optimization of device performance and operating parameters, dramatically reducing the time and costs needed to reach volume production.

In this frame, the activity of the Ph.D. candidate is structured as follows:

- Numerical modeling and simulation: the activity will involve the development of innovative simulation tools for applications in the field of power devices, with the aim of accurately predicting most critical device performances as



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| | <p>a function of device layout, process conditions and process variations. The activity will begin with IGBTs and will move later to different devices on the basis of the company needs and roadmap. Being Power devices 3D structures, particular focus is needed on advanced 3D modeling capabilities, such as mesh generation and adaptive mesh refinement, which can help to improve simulation accuracy and efficiency. The activity will also include the evaluation of commercially available tools and their potential to evaluate the impact of process variations associated with mass production.</p> <ul style="list-style-type: none"> - Experimental characterization: the activity involves the experimental characterization of the device parameters and characteristics, with the aim of providing feedback for modeling and simulation optimization. Suitable setup will be built to safely conduct the activity. |
| Methods and techniques that will be developed and used to carry out the research | <p>To carry out the planned activity, the candidate will:</p> <ul style="list-style-type: none"> - Become aware of the whole manufacturing process of advanced semiconductor devices, that will be fabricated in ST on 300 mm wafers. - Develop a critical understanding of the key process steps and their influence on the device behavior - Perform numerical simulations of such devices to assess the critical parameters and their dependences - Perform experimental characterization of the devices to extract the key parameters to benchmark the simulation results against. <p>The modeling/simulation activity will be mainly conducted in ST while the possibility to conduct the experimental characterization in the power device lab. at Politecnico di Milano will be pursued.</p> |
| Educational objectives | <p>The Ph.D. candidate will develop a sound education in the world of research and development for power management and efficient energy conversion. This is a key figure to drive the next technological revolution associated with car electrification and will need solid background and know-how in physics, technology and materials engineering.</p> <p>The candidate will be required to manage interdisciplinary issues, perform and interpret complex experiments and</p> |



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| | <p>benchmark new tools in an international context.</p> <p>Experts in new devices and process development for their fabrication will be more and more crucial to grant competitiveness and innovation content in the semiconductor world, which is finally recognized as a strategic sector for European industry, see: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_it</p> |
| Job opportunities | <p>Huge investments are foreseen in Europe for the semiconductor world, due to the recent crisis faced in several applications field. Devices and process experts will become crucial to enable the technological revolution, particularly in the power semiconductor market. For this reason, the candidate will be attractive to cover highly-qualified positions in a wide range of industries related with production, development and application of semiconductor devices. Private and public R&D centers will also be a potential target for the candidate's future career.</p> |
| Composition of the research group | <p>2 Full Professors 0 Associated Professors 1 Assistant Professors 6 PhD Students</p> |
| Name of the research directors | Alessandro Sottocornola Spinelli; Paola Zuliani |

| Contacts |
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| <p>E-mail: alessandro.spinelli@polimi.it; Phone: +39 02 2399 4001 https://spinelli.faculty.polimi.it/</p> <p>E-mail: paola.zuliani@st.com, Phone: +39 039 6037924 www.st.com</p> |

| Additional support - Financial aid per PhD student per year (gross amount) | |
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| Housing - Foreign Students | -- |
| Housing - Out-of-town residents (more than 80Km out of Milano) | -- |



| Scholarship Increase for a period abroad | |
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| Amount monthly | 700.0 € |
| By number of months | 6 |

| National Operational Program for Research and Innovation | |
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| Company where the candidate will attend the stage (name and brief description) | STMICROELECTRONICS S.R.L. |
| By number of months at the company | 6 |
| Institution or company where the candidate will spend the period abroad (name and brief description) | STMICROELECTRONICS S.R.L., Crolles, Francia |
| By number of months abroad | 6 |

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.

TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student.

There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

COMPUTER AVAILABILITY: individual use.

DESK AVAILABILITY: individual use.