POLITECNICO DI MILANO

PhD in FISICA / PHYSICS - 39th cycle

THEMATIC Research Field: STUDY AND REALIZATION OF 3-DIMENSIONAL TRANSISTORS BASED ON 1D AND 2D MATERIALS

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	It is anticipated that the scaling of silicon (Si) complementary metal-oxide-semiconductor (CMOS) devices is close to its end, an alternative technology capable of maintaining advances in computing power and energy efficiency is CNT-based electronics. A range of methods have been developed to prepare high-purity semiconducting CNTs suitable for use in integrated circuits, and 5 nm CNT transistors with superior performance to that of Si-CMOS have been demonstrated. Computers based on CNT field-effect transistors (FETs) have been theoretically predicted to improve the power-performance by a factor of 10 over computers based on silicon CMOS technology. However, the fabrication of high-performance CNT-FETs, and the realization of the full potential of CNTs, are extremely challenging. The proposed activity concerns the modelling of nano-devices based on CNT-FETs and potential 2D materials-FETs; the study of the device performances; the realization of 1D and 2D materials-FETs systems by means of biofabrication and nanofabrication; the basic experimental tests of these devices. The project has broad implications in the world of physics, biotechnology and nanoelectronics. In particular, they could lead to revolutionary applications in fields such as nanofabrication, computing, nanodevices.
Methods and techniques that will be developed and used to carry out the research	Modelling: Finite Element based numerical approach will be employed for the present project. The motivation is the need of coupling together different kinds of Physics, an

	essential condition for numerically address the functionalities of the proposed device.Nanofabrication: Electron beam lithography and optical lithography, materials deposition, chemichal etching and other deposition techniques for fabricating hybrid samples. Nanocharacterization: AFM, SEM, I-V in probe stations, SPM and other deposition techniques for characterization of hybrid nanomaterials +biomaterials samples.
Educational objectives	The topic is highly interdisciplinary. The main outcome is a trans-disciplinary language and the understanding of multi-scales problems, while keeping a physics solid base.
Job opportunities	Academic; Research institutes; Bio Tech R&D; Electronics and microdevice companies.
Composition of the research group	1 Full Professors 1 Associated Professors 6 Assistant Professors 8 PhD Students
Name of the research directors	Garoli Denis, Remo Proietti

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

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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activities Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per 3 years: max 5.707,20 euros per student.

Teaching assistantship: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 and desk availability: *individual use*