POLITECNICO DI MILANO

PhD in FISICA / PHYSICS - 39th cycle

PNRR 118 PNRR Research Field: GROWTH AND CHARACTERIZATION OF ANTIFERROMAGNETIC OXIDES FOR ORGANIC SPINTRONICS

Monthly net income of PhDscholarship (max 36 months)
€ 1195.5 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	With reference to the *Piano Nazionale della Ricerca* (PNR 2021-2027), and according to the research priority actions on ?nuovi materiali e nuove tecnologie per batterie ad alta capacità? within the "CLIMA, ENERGIA, MOBILITÀ SOSTENIBILE", and on "Tecnologie quantistiche per la sensoristica e la metrologia" and "Tecnologie quantistiche per l'efficienza e la sostenibilità energetica", within the "DIGITALE, INDUSTRIA, AEROSPAZIO" research and innovation areas, we will conduct research on the design of new functional materials useful to reduce energy consumption and to enhance performances of electronic devices (*green ICT*).The context of the activity is the research in Organic Spintronics, whose goal is to develop hybrid low-dimensional systems involving molecular materials and magnetic materials. In particular, the research group is now developing interfaces based on antiferromagnetic (AF) materials, which are at the forefront of research in spintronics, also on account of the opportunity given by the possible exploitation of such materials in magnonics. The latter is a scientific and technological approach aiming to generate, transport and detect pure magnetic signals, in form of so-called *spin waves*, to transport information. This would be achieved without correspondingly transport electronic charge, which a significant reduction of energy consumption due to dissipation.On the other hand, the use of molecular materials will ensure a great tunability, on account of the large variety of molecules that may be employed, and it will also help to attain low processing costs, together with other potential achievements such as environmental

	safety and biological compatibility.We also underline that most AF materials that are going to be the object of investigations will be transition-metal oxides. The latter display a variety of physical properties, thus making them a vast playground for fundamental investigations and appealing for technological applications, which span from the mentioned magnetic ones to optoelectronics, sensors, catalysis and as anode materials in batteries. The study of such materials is thus supported by a richness of potential applications within several possible interdisciplinary approaches.Hybrid low-dimensional magnetic systems are, in particular, expected to be exploited in novel green electronic applications, characterized by a significant reduction of energy consumption and production costs.
Methods and techniques that will be developed and used to carry out the research	The research activity will mainly focus on the preparation of thin films of antiferromagnetic oxides and their employment in hybrid layered systems, locally prepared in ultra-high vacuum by Molecular Beam Epitaxy (MBE) and Organic MBE (OMBE), respectively. The research is experimental and involves crystallographic (electron diffraction), chemical (electron spectroscopies) and morphological (scanning tunneling microscopy) characterizations in the context of various collaborative activities, in particular relating to the field of Organic Spintronics. The use of magnetic characterization techniques, in particular based on synchrotron radiation, is also envisaged.
Educational objectives	The student will learn to start, develop, and complete an original and innovative piece of research, which culminates in his or her PhD thesis. In particular, the student will learn the physics of low-dimensional magnetic systems through advanced experimental studies and will become an expert of Scanning Tunneling Microscopy (STM).
Job opportunities	The PhD programme provides the following principal career options: - research work at university or in public or private research centres, both fundamental and applied; - work at R&D departments in companies in any area of

	physics, material science and engineering; - consultancy or data scientist in companies; - entrepreneurship in high-technology sectors; - teaching physics or mathematics at primary and secondary level schools.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 1 PhD Students
Name of the research directors	Alberto Brambilla - Andrea Picone

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	597.75 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	NA
By number of months at the company	0
Institution or company where the candidate will spend the period abroad (name and brief description)	The candidate will carry out a 6-months secondment activity in an EU-located research group active in the Organic Spintronics network, which is currently established also within collaborative European projects
By number of months abroad	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 **4.872,90** 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: *a personal laptop and a desk will be made available.*