



PhD in FISICA / PHYSICS - 38th cycle

INTERDISCIPLINARY Research Field: PHYSICAL / CHEMICAL ANALYSIS OF NANOSTRUCTURED INTERFACES FOR NEW GENERATION BATTERIES

Monthly net income of PhDscholarship (max 36 months)

€ 1195.0

In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Research, during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

Interdisciplinary PhD Grant

The PhD research will be carried out in collaboration with research groups of the PhD programme in "**ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY**".

See <https://www.dottorato.polimi.it/?id=422&L=1> for further information.

In the progress of new generation batteries (eg. metallic Li, Li-S, Li-air, Na, Zn, solid electrolyte, thin film), which promises advantages in terms of energy density, power, durability and safety, the development of new nanostructured materials and a better knowledge of the intercalation mechanisms at the micro-nanoscale length-scale become crucial. In particular, the stability, durability and performance of a battery are affected by phenomena at the interface during electrochemical cycles, which can lead to the formation of deposits, phase changes, structural modifications and degradation. Many studies focus on the physical / chemical properties of the surface, others on the effects on battery operation. In general, there is a lack of detailed studies that try to link local analysis at the nanoscale with device performances. The goal of this research is to fill this gap and to analyze the electrode / electrolyte interface using microscopic, spectroscopic and electrochemical techniques on model surfaces under in-operando conditions, i.e. similar to those of a real battery

(https://www.fisi.polimi.it/en/research/research_structures/laboratories/solinano). We focus the study on intercalation in graphitic materials, and the modifications in oxide



	electrodes used as cathodes in Zn ion batteries.
Methods and techniques that will be developed and used to carry out the research	To study the physical / chemical properties of an interface, high surface sensitivity and high spatial resolution techniques are required. Scanning probe microscopy, such as the atomic force microscope (AFM), allows a local morphological analysis of the electrode surface. The combination with Raman spectroscopy and cyclic voltammetry allows then to simultaneously monitor the chemical and structural evolution of the surface and the electrochemical processes that take place there. An electrochemical-AFM (EC-AFM) is available at the Solinano- ζ interdepartmental laboratory which allows the investigation of solid-liquid interfaces in electrolytic solutions, in combination with voltammetry and Raman chemical maps. A parallel development activity of nanostructured films for batteries, active at the Nanolab, will allow to identify the model surfaces under study. It will be possible to combine further investigations, such as SEM microscopy, STM microscopy and photoemission spectroscopy.
Educational objectives	The research project brings the candidate to the frontier of research in the field of nanomaterials for batteries and energy storage. The preparation and formation increases the experimental abilities of the candidate and gives a solid knowledge in combined microscopy, spectroscopy and electrochemical investigations (https://www.fisi.polimi.it/en/research/research_structures/laboratories/solinano).
Job opportunities	Applied research in physical/chemical properties of materials and electrochemical and electrode analysis opens professional carriers in National and International Universities, gives opportunities in hiring in factories and companies involved in energy storage and batteries, such as De Nora, Merch, etc.
Composition of the research group	2 Full Professors 1 Associated Professors 1 Assistant Professors 2 PhD Students
Name of the research directors	Gianlorenzo Bussetti; Andrea Libassi



Contacts

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Additional support - Financial aid per PhD student per year (gross amount)	
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Housing - Foreign Students	--
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Housing - Out-of-town residents (more than 80Km out of Milano)	--
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Scholarship Increase for a period abroad	
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Amount monthly	597.50 €
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By number of months	6
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Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities per year :

1624,30 euros per student for each year.

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: shared use computer and desk