SUSTAINABLE MATERIALS, PROCESSES AND SYSTEMS FOR ENERGY TRANSITION

Roma La Sapienza/MUR - Multiscale characterization of advanced materials and innovative devices for energy transition

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Context of the research activity	The project will focus on defining multi-scale characterisation protocols and developing advanced nanocharacterization approaches essential for the analysis of new, including low-dimensional (2D), materials. Using state-of-the-art electron microscopy and other nanocharacterization techniques, the project aims to establish correlative protocols for advanced materials critical to energy transition applications. These cutting-edge methods are essential to gain a comprehensive understanding of nanoscale properties, which will drive innovation in energy efficient technologies and contribute significantly to the development of sustainable energy solutions. Progetto finanziato dal PIANO NAZIONALE RIPRESA E RESILIENZA (PNRR) MISSIONE 4 -“ISTRUZIONE E RICERCA”- COMPONENTE 2 DALLA RICERCA ALL’IMPRESA – LINEA DI INVESTIMENTO 3.1 - AVVISO PUBBLICO MUR N.3264 del 28/12/2021- PROGETTO IENTRANCE@ENL-INFRASTRUCTURE FOR ENERGY TRANSITION AND CIRCULAR ECONOMY@ EURO NANOLAB - FINANZIATO DALL’UNIONE EUROPEA NEXTGENERATIONEU - CUP B33C22000710006.
	The project to be developed during the PhD will contribute to provide some answers to the wide and critical need for advanced characterization techniques in the study of new materials, especially those with low dimensionality (2D). The overall objective is to contribute to the development of a future generation of nanomaterials, processes and systems aimed at minimizing the environmental impact associated with the production, storage, distribution and use of energy. This approach is based on the promotion of a sustainable and circular economy. To achieve this, the project will focus on defining multi-scale characterization protocols and developing advanced nano-characterization approaches. These protocols and approaches are essential for the detailed analysis of materials and devices that play a crucial role in energy transition applications.

Objectives	Using state-of-the-art electron microscopy and nanocharacterization techniques, the project aims to establish correlative protocols for these advanced materials. The integration of these cutting-edge methods is essential to gain a comprehensive understanding of material properties at the nanoscale, which is crucial to drive innovation in energy efficient technologies and contribute significantly to the development of sustainable energy solutions. Research will include the development of multi-scale and multi-technique protocols for the chemical, physical, functional and mechanical characterization of materials and associated devices. This comprehensive approach is necessary for the applications of interest in the energy transition, in particular from a sustainable and circular economy perspective. In this context, the specific objective of this doctoral fellowship will be the use and development of tomography-based techniques and related protocols for the multi-scale study of advanced materials and innovative devices for the energy transition. This PhD fellowship is partly supported by the project "Infrastructure for Energy Transition and Circular Economy @ EuroNanoLab" (iENTRANCE@ENL) within the NextGenerationEU (NGEU) programme (call RI-PNRR); for more details see www.ientrance.eu. The support of this project underlines the importance and relevance of the research in the context of broader European efforts to move towards more sustainable and circular economic models. The results of this project are expected to have far-reaching implications for the field of energy transition. By developing new characterization techniques and protocols, the research will enable a deeper understanding of the materials and devices that are critical for energy efficient technologies. This in turn will facilitate the development of more efficient and sustainable energy solutions, helping to reduce the environmental impact of energy production and use. Furthermore, the project's focus on low-dimensional materials is particularly relevant given the unique properties of these materials, which often make them ideal candidates for advanced energy applications. The ability to characterize these materials at multiple scales will provide valuable insights that can drive the development of next generation energy technologies. In addition to energy applications, the advanced materials characterized in this project have a wide range of potential applications, including quantum computing, electronics, photonics and nanomedicine. For example, low-dimensional materials can play a crucial role in the development of quantum devices, which require precise control at the atomic scale. In electronics and photonics, these materials can lead to the creation of faster, smaller and more efficient devices. In nanomedicine, advanced materials can be used to develop new diagnostic and therapeutic tools that operate at the molecular level, leading to more effective and targeted treatments. In summary, this PhD project has the potential to make a significant contribution to the field of energy transition. Through the development and application of advanced characterization techniques, the research will provide a comprehensive understanding of the materials and devices that are essential for sustainable energy solutions. The support from the iENTRANCE@ENL project and the NGEU programme underlines the importance of this research in the broader context of European efforts to achieve a sustainable and circular economy. This project aims not only to advance scientific knowledge, but also to promote the development of technologies that can have a positive impact on the environment and society as a whole.

Skills and competencies for the development of the activity	Knowledge and/or experience on at least one of these topics: Materials Science, Semiconductor, Physics of the Matter, Inorganic Chemistry, Multiscale Characterizations, Electron Microscopies, Scanning Probe Microscopies, Tomography, Imaging post-processing, Modeling and simulation