MATERIALS SCIENCE AND TECHNOLOGY

IIT - High-performance and highly resilient secondary batteries for Space applications

Funded By	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA [P.iva/CF:09198791007]
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Context of the research activity	High performance and resilient energy storage devices are the primary objective when it comes down to research in the secondary batteries field. For this reason, a number of solutions have been introduced, based on different chemistries, additives, electrodes engineering, etc. High performance and resilience have become even more strategic for Space applications, where the need for high-power consuming devices has been growing rapidly, and where local maintenance is very challenging. In this respect, the proposed activity aims at the development of secondary batteries based on innovative architectures which can provide extreme temperature resilience together with high performance. The approach will be based on the exploitations of solutions coming from the microelectronics sector, through the introductions of processes capable of making available well established microelectronics solutions for electrochemical purposes. At the same time, particular attention will be dedicated to the use of materials and methods involving eco-friendly resources. In this respect, batteries such as Li-ion batteries and post-Li energy storage systems are the most suited choices. However, safety remains an essential requirement, and problems related to the use of liquid electrolytes based on organic solvents (flammable, volatile, toxic) still need to be addressed. Among others, solid-state (polymer-based, hybrid, composite) electrolytes represent a truly suited option in this respect, and their development is fundamental for the future generation of safe, resilient, high-performing energy storage devices.
	The main objectives of this PhD are: - To investigate and develop new cathode and anode materials for use in next-generation batteries that offer higher energy density, temperature resilient, longer cycle life, and improved safety compared to current state-of-the-art materials. - To develop and optimize new manufacturing and fabrication processes for battery components and materials, with a focus on scalability and cost-effectiveness. - To explore and optimize new battery architectures, such as solid-state batteries, lithium-sulfur batteries, and sodium-ion batteries, that offer

Objectives	improved performance and safety characteristics compared to conventional lithium-ion batteries. - To investigate the electrochemical behaviour of batteries under extreme conditions, such as high temperatures or high discharge rates, and develop strategies for improving the performance and safety of batteries under these conditions. - Characterization of synthesized materials and optimization of their physico-chemical, structural-morphological and electrochemical properties, such as X-ray diffraction, scanning electron microscopy, transmission electron microscopy, and thermal analysis. - Assembly of the synthesized materials in next-generation energy storage devices and their characterization in terms of electrochemical performance, compatibility and stability with different electrode/electrolyte materials.

Skills and competencies for the development of the activity	Candidates with education in Chemistry, Materials Science, Physics, or similar are sought. Candidates should have a strong chemistry and/or materials preparation background and high motivation to learn through advanced research. Good knowledge of practical attitude for the lab activities and problem-solving skills are also appreciated. A background in characterization techniques and modelling of functional materials is also welcome. A background in electrochemistry and electrochemical characterization techniques, such as cyclic voltammetry and impedance spectroscopy, is also welcome. Good knowledge of English, both spoken and written, is required.