PhD in Material Science and Technology

Research Title: Innovative materials for Li-ion and post Li-ion cells

Funded by	DISAT – Dipartimento di Eccellenza

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Context of the research activity	The ever-increasing demand for electric energy storage, ranging from portable electronics to electric vehicles and to renewable power stations, stimulates the development of improved rechargeable lithium batteries or other rechargeable battery systems with substantially enhanced energy density and greatly reduced cost. Batteries play a central role in the transition from fossil fuels to renewable energy. There is an urgent need to develop versatile and high-performance energy systems for power grip application and transport. Other important sectors in which batteries are strategical are aerospace, medical devices and robotics. The development of more and more performing batteries would lead to the attainment of innovations in new industrial fields, since the global demand for batteries is huge and it will grow even further in future. State of art Li ion batteries are limited in terms of gravimetric capacity energy density, thus there is the need to develop new solutions toward high-tech advances. In terms of technical characteristics, next generation batteries will have to approach theoretical limits of storage capacity, enhance their power capability and power density, increase the cycling lifetime in order to guarantee long and stable operational life, be safe even in extreme low and high temperatures conditions. For these reasons there is the need to study new battery materials or chemistries that can assure better performances compared to the state of art materials currently used. Furthermore, a perfect knowledge of battery interfaces will allow to select new designs. Finally, smart-sensing and/or self-healing devices will be also a requirement. The topic of this Doctoral Research will be developed in the context of a

	new Flagship initiative, namely Battery 2030+, in the frame of the European Community Projects.

Objectives	One of the main objectives of the research will be the development of smart battery cells and intelligent functionalities because they will enable to achieve safer and durable battery chemistries. Smart batteries need embedded sensors to monitor the complex reactions that happen inside the batteries themselves. In order to extend the battery life self-healing concepts need to be developed, that will be inspired from the medical science and biology. Modern medicine has found a way to influence these processes to treat diseases, thus a similar approach will be required or inspire the research in the field. Another objective is to realize new battery designs, and innovative electrodes based of blended materials that can sustain high power and high energy densities and will assure safety requirements needed for battery commercialization. A disruptive vision like this needs functionalities integrated into the battery, capable of spatially and time-resolved monitoring. Sensing systems development will serve to identify defective components or local spots of the cell that need to be repaired.

Skills and competencies for the development of the activity	Candidates must have an interest in the proposed topics. Candidates are required to have a graduation in one of the followings: Chemical Engineering, Chemistry, Nano/biotechnology, Material Science, Material Engineering, Biology Degree.