CHEMICAL ENGINEERING

DISAT - Materials Development and Sustainability Assessment for Next-Generation Lithium–Sulfur Batteries

Funded By	Dipartimento DISAT
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Context of the research activity	The PhD project will focus on the development, engineering, characterization, and sustainability assessment of innovative components for lithium–sulfur batteries within the frame of a Horizon Europe EU project (TALISSMAN). The candidate will contribute to the development and engineering of advanced cathode materials, solid/gel electrolytes, and eco-design methodologies integrating life cycle assessment and recyclability criteria, responding to the critical challenges of cost, raw material availability, safety, and sustainability in electrochemical storage.
Objectives	Lithium–sulfur (Li–S) batteries are considered one of the most promising next-generation energy storage technologies, thanks to their high theoretical specific energy (~2600 Wh kg¿¹), low cost, and the abundance and environmental benignity of sulfur compared to transition metal-based cathodes used in lithium-ion cells. However, the practical deployment of Li–S systems is currently limited by several challenges, including the instability of the lithium metal anode, the polysulfide shuttle effect, and the complex formation of the solid–electrolyte interphase, which affect both performance and safety. Recent research efforts are therefore focused on advanced electrode architectures, solid or hybrid electrolytes, and eco-design strategies aimed at achieving high-performance and sustainable Li–S batteries suitable for electromobility and stationary applications. The research activities will address both the materials engineering and sustainability aspects of advanced lithium–sulfur (Li–S) battery systems. The PhD candidate will synthesize and characterize: cathode materials based on carbon/sulfur composites with the development of catalytic additives; perform physicochemical and electrochemical analyses (e.g., Raman, XPS, FESEM, EIS) to study degradation mechanisms; contribute to the eco-design and Life Cycle Assessment (LCA) of Li–S battery cells, ensuring compliance with the EU Battery Regulation and integration of Safe and Sustainable-by-Design principles. More in general, the PhD project aims to generate a holistic understanding of how material selection, electrode engineering, and recycling processes influence the environmental and techno-economic performance of next-generation solid-state Li–S batteries. This cross-disciplinary position will provide the candidate with expertise in

	electrochemistry, sustainability assessment, and circular economy applied to energy storage technologies. The research aims to integrate fundamental materials concepts with application-oriented cell engineering, thereby positioning the candidate at the interface of academia and industry within a dynamic and internationally collaborative research environment.

Skills and competencies for the development of the activity	Candidates are required to have defended a MSc Thesis in: Chemical Engineering, Materials Engineering, Industrial Chemistry, Chemistry, Materials Science. The candidate is required to have skills in chemical preparation and characterization of materials as well as, possibly experience in electrochemical characterization procedures. In addition, the candidate must demonstrate adaptability in both academic and industrial research and a good knowledge of the English language. Knowledge of LCA methodologies, environmental sustainability, or battery technology will be considered an asset. Excellent teamwork and communication skills in an international environment are required.