MATERIALS SCIENCE AND TECHNOLOGY

IIT - Electrochemical devices for integrated carbon capture and conversion

Funded By	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA [P.iva/CF:09198791007]
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Context of the research activity	The project develops materials and electrochemical reactors to integrate CO2 capture and conversion into a single energetic process. Its goal is to create an efficient and durable system capable of electrochemically reducing CO2 into e-fuel precursors (such as carbon monoxide) without the need for purification from flue gas or atmospheric mixtures.
Objectives	Carbon dioxide (CO2) emissions from anthropogenic activities are among the main contributors to the greenhouse effect, which is continuously increasing global temperatures. To combat the accumulation of CO2 in the atmosphere, carbon capture and utilization (CCU) represents a promising solution - not only to reduce CO2 concentrations but also to transform it into an energy resource for the future. Electrochemical technologies are ideal candidates for CCU, as they are fully powered by electricity that can be sourced from renewable energy. However, current technologies for the electroreduction of CO2 into valuable products (e.g., CO, HCOOH, C2H4) require prior purification of CO2 from other flue gas or atmospheric components, depending on its source. This purification often involves highly energy-demanding thermal steps, which are unsuitable for the electrification of future industrial processes. This project aims to develop an electrolyzer capable of converting CO2 without the need for such high-temperature purification steps. This can be achieved by designing the electrolyzer to operate directly with the CO2 capture solution, rather than with gaseous CO2, as the feedstock. During the doctoral scholarship, the candidate will optimize the materials used within the electrolyzer as well as their electrochemical performance. Metal–organic single-atom catalysts and polymeric porous membranes will be central to the project, with the goal of advancing the electrolyzer from lab scale to TRL 5–6 during the course of the PhD. The candidate will be responsible for the morphological, chemical, and electrochemical characterization of the materials and reactors developed and optimized throughout the research.
Skills and	The candidates should: o Hold a degree in a STEM discipline.

competencies for the development of the activity	o Demonstrate strong independence in planning and conducting research activities. o Possess excellent teamwork and collaboration skills. o Communicate results effectively in English to a diverse audience. Previous experience in electrochemistry is considered a plus.