SUSTAINABLE MATERIALS, PROCESSES AND SYSTEMS FOR ENERGY TRANSITION

Sustainable materials&processes for energy storage and CO2-capture exploiting green supercapacitors

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Context of the research activity	In the past decades our society is putting much effort to disengage its energy needs from fossil fuels in order to reduce CO2 emission. However, in the foreseeable future, carbon-based liquid fuels will continue to play an important role. It is therefore essential to push the enhancement of renewable source performance, together with their cost reduction, and to investigate possibilities of using renewable energy to recycle CO2. When two solutions with different composition are mixed, free energy of mixing is released. This phenomenon was deeply investigated in the last decades in order to harvest the so-called salinity gradient power. One of the most incipient technology that allows to harvest this energy is the Capacitive Mixing (CapMix) and its working mechanism is based on a fluidic electrochemical cell, similar to a supercapacitor. Since this mixing phenomenon holds true for both liquids and gases, the idea is to harvest energy from anthropic CO2. The ERC funded CO2CAP project proposes for the first time to exploit a green ionic liquid (IL), i.e. a bio-derived molten salt at room temperature, both as electrolyte and CO2 absorbing medium in a CapMix cell. The principle consists of flowing a concentrated CO2 gas stream, alternated to vacuum step, in the IL during the charging/discharging of two electrodes. The CO2 will induce an electric double layer (EDL) expansion of charges at the electrode/IL interface thereby converting the released mixing energy into electrical energy.
Objectives	Scholarship funded by IIT. Main seat to carry out the research: CENTER FOR SUSTAINABLE FUTURE TECHNOLOGIES, ISTITUTO ITALIANO DI TECNOLOGIA, Torino Supervisor: Prof. Andrea Lamberti (andrea.lamberti@iit.it) The main research objectives of this PhD thesis include (not necessarily all): - Design, fabrication and electrical/electrochemical characterization of a customized fluidic supercapacitor exploiting innovative architectures able to overcome encumbrance limitations and gas flow management.

	- Innovative electrodes - study and development of innovative materials for electrode fabrication able to exploit both electric-double layer formation and its expansion during CapMix cycles - Innovative electrolytes - characterization of innovative materials to be used at the same time as electrolyte and CO2 absorber into a fluidic supercapacitor.

Skills and competencies for the development of the activity	Candidates should have a solid engineering background and strong motivation to learn through advanced research. Expertise in physics, nanomaterials, electrochemistry, advanced processes and nanotechnologies is preferred. In particular the knowledge of the main electrochemical characterization techniques is required. Problem solving ability and practical experience in laboratory activity is preferred.