Synthesis and characterization of inorganic multicomponent adsorbents for selective extraction lithium salts by Hybrid Capacitive Deionization (HCDI)

The global market for lithium salts is a fast growing and is expected to reach 30$ billion value by 2020. Increasing rapidly demand of Li ions is caused by their application for portable electronics, for electric and hybrid cars and for electrical intelligent grids. Information on individual lithium resources has been collected and divided into two main categories: primarily, where lithium is extracted from extraction from natural as minerals, salt lakes, underground brines or seawater, and secondary, by the recycling of lithium from electronic waste and lithium ions batteries. However, the most promising lithium ions depositions are estimated at groundwater's and brines where its content is evaluated to be $2.55 \cdot 10^{14}$ kg. Industrial processes for desalination seawater and geothermal water are carried out by high energetical and high temperature technologies such as reverse osmosis or multi stage distillation. This fact led to a dynamic search for less energetic techniques, which have been finalized by the combination classic capacitive deionization and desalination batteries, namely Hybrid Capacitive Deionization (HCDI), presented at Figure 1. Moreover, by using ion-selective electrode materials it is possible to create a process of desalination of water with simultaneous separation of selected element, in this case, Li^+.

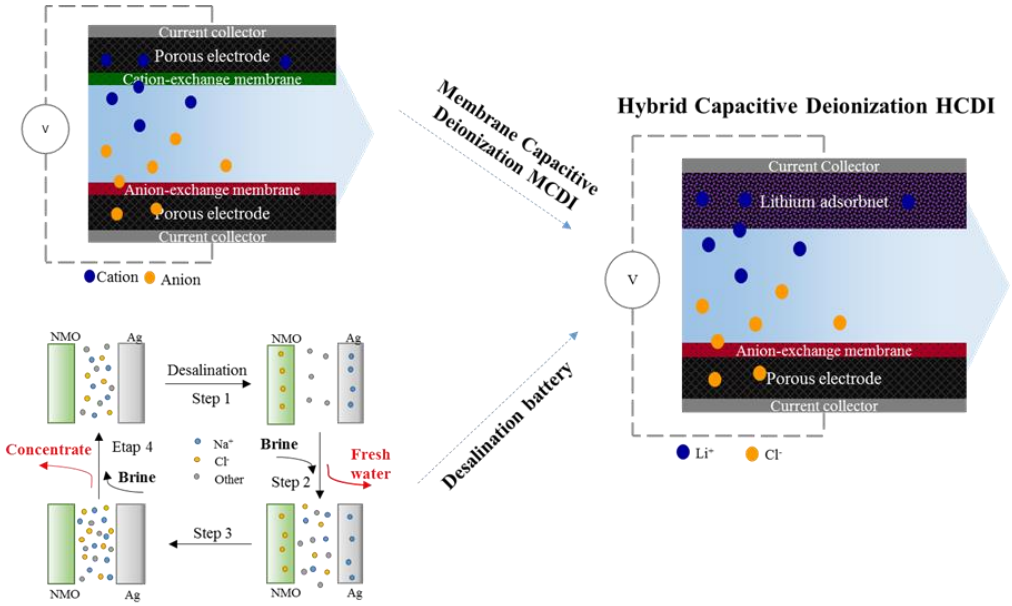

Figure 1. Innovative Hybrid Capacitive Deionization of combination of MCDI and Desalination battery.

The aim of the proposed project is an attempt for obtaining selective inorganic adsorbents capable to capturing lithium ions from multicomponent aqueous solutions. These materials will be synthesized by two-staged synergies of alkali carbonates and other dopants to create new range of compounds. These materials should exhibit a high specific surface area, have a relatively low resistance and be capable to collecting electrical charges. The developed materials will be used in hybrid Capacitive Deionization process to selectively extraction lithium from multicomponent aqueous solution. This process is well-defined and used in industrial practice. As opposite to other desalination techniques such as reverse osmosis, nano- and ultrafiltration, or multi-stage distillation HCDI is characterized by the lowest energy requirements at comparable adsorption capacities. This property provides the multifunctionality of process and also allow to remove lithium ions and produce energy at the same time. Hence, presented project will be divided into two parts. The first part of study will include the synthesis of selective materials with extremely good thermal and mechanical properties and be capable of insertion/deinsertion lithium ions and also poses satisfactory electrical conductivity. In the second part, prepared materials will be evaluated by hybrid capacitive deionization. During tests, parameters such as adsorption/desorption capacity, energy efficiency or extraction rate will be measured.
The materials and their characteristic will be developed using knowledge of polymer and carbon technologies, materials engineering and also electrochemistry science. This synergy provides interdisciplinary nature of proposed project.