Postdoctoral contract
Production of 3D microsupercapacitors

Keywords: energy, liquid synthesis, oxide, electrochemistry, plasma

Context: The subject concerns the development and miniaturization of energy storage devices which meet the requirements of nomadic electronic systems and autonomous sensors which have seen significant growth over the last 20 years. The energy sources that can be incorporated into these systems are in full development because they must respond to the miniaturization of electronic devices which require compact and efficient energy sources. Our project aims to develop a microstructured and nanostructured energy storage device (3D micro-supercapacitor) capable of covering the power requirements of autonomous electronic systems. These micro-supercapacitors make it possible to deliver high power in a very short time. They can be coupled with microbatteries in medical systems, to improve their performance, particularly their lifespan, or even with photovoltaic systems to design an autonomous energy source. Microstructuring of the silicon substrate will be carried out to increase the specific surface area developed. On this 3D substrate, carbon will be deposited by plasma (GREMI) then a homogeneous and conformal layer of a transition metal oxide constituting the electrode will be deposited by liquid. The electrode materials chosen will allow us to use lithium-based electrolytes.
The aim of the subject is therefore to create a 3D micro-supercapacitor which can store more energy than current systems while retaining the power and cyclability properties. To achieve this objective, one of the steps to be carried out is the conformal deposition of carbon by plasma method in 3D Si substrates then depositing the active material (cathode) by liquid method (patented method (n°1359144)) allowing a reduction of the costs compared to traditional deposition methods and thickness control per deposition. This work will be done in collaboration with GREMI and CEMHTI located in Orléans to respectively carry out carbon deposits and electrochemical measurements and GREMAN located in Blois for oxide deposits.

Objective: the objective is to produce a 3D microsupercapacitor with high capacity, energy density and power. The final goal is to couple the 3D microsupercapacitor to a microbattery for use in the medical field. The development of the electrodes will be done in Blois with travel to Orléans to carry out the electrochemical characterizations (CEMHTI laboratory). Three laboratories are working on this project, 2 in Orléans, and one in Blois. The journeys are covered by the laboratory.

Références

1. Poirot Nathalie, Tillocher Thomas, and Raynal Pierre-Ivan, “Conformal coating by liquid route on three-dimensional topology” Eur. Phys. J. Spec. Top. (2022), doi.org/10.1140/epjs/s11734-022-00579-6
2. N. Poirot, V. Rajalingam, R.N. Murgu, R. Omnée, E. Raymundo-Piñero, “Nanotexturing TiO_2 over Carbon Nanotubes for High-energy and High-power Density Pseudocapacitors”, Front. Mater. (2022) DOI 10.3389/fmats.2022.1011782
3. N. Poirot, M. Gabard, M. Boufnichel, R. Omnée, Encarnacion Raymundo-Piñero, “A suistainable approach for the development of TiO_2 based 3D electrodes for micro-supercapacitors”, Batteries, 2023,9, 258, doi.org/10.3390/batteries9050258
4. N. Poirot, F. Ghamouss, M. Gabard, T. Tillocher, patent: WO2018091844 - PRODUCTION OF 3D BATTERIES BY WET PROCESSING-2018

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Skills sought: synthesis of oxide materials by liquid method, deposition of thin layers, characterization of materials: XRD, SEM, ATG/ATD/FTIR. Experience in electrochemistry would be a plus.
Scientific fields: synthesis of materials, energy, chemistry, thin layers.
Duration: 18 months from November2024
Salary range: between 45 and 50 keuros gross/year

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