Carbon-based electrodes for high energy and power supercapacitors

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Supercapacitors are electrochemical energy storage devices able to store energy based on two main mechanisms (Fig. 1), which are strongly dependent on the used electrode materials. In pure carbon materials, the charge is stored at the interface with the electrolyte, by forming an electrical double layer (EDL). In such case, the mechanism is called capacitive [1]. In metal-based systems (oxides, nitrides, sulfides etc.), rapid surface redox reactions occur with the electrolyte, mechanism known as *pseudo*-capacitance [2]. Both types of materials present advantages and limitations and combing both might lead to improved performance. One important characteristic to be improved is the energy density, which depends on the material capacitance and the electrolyte potential. These properties are aimed to be enhanced herein by i) optimizing the material properties, ii) designing optimal electrolyte and by iii) understanding the storage mechanisms. The carbon-based materials will be synthesized by green procedures and their features (porosity, surface chemistry, structure and morphology) will be tuned to increase the charge capacitance. Eco-friendly and safety gel-like and concentrated electrolytes will be designed to maximize their voltage window and stability over-cycling. The storage mechanisms will be evaluated by classical electrochemical methods (cyclic voltammetry, galvanostatic charge/discharge and impedance spectroscopy) combined with *in-situ* techniques (electrochemical quartz balance and Raman spectroscopy). The PhD student will benefit of IS2M certified technical platforms and qualified technical staff, to characterize the physico-chemical properties of the materials. Nevertheless, the project will be performed in the framework of RS2E (Reseau sur le Stockage Electrochimique d'Energie), so that the future PhD student can benefit from interactions with scientific researchers expert in the field of energy storage.

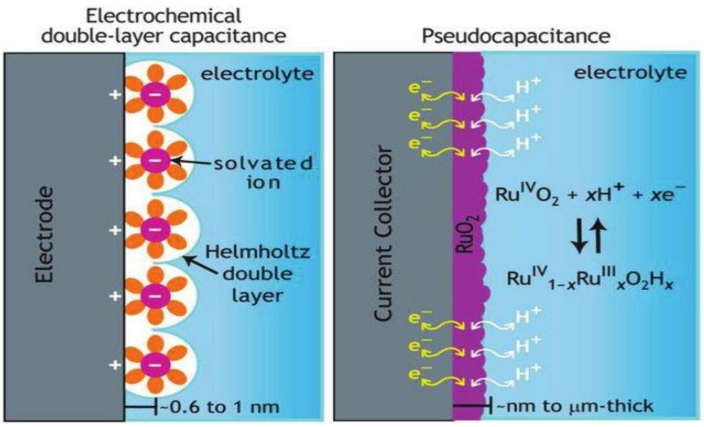

Figure 1 :Schematic representation of charge storing mechanisms using carbon (left) and RuO_2 (right) materials.

[1] A Platek, C Ghimbeu *et al.*, ACS Appl Mater & Interf **13,** 2584 (2021).
[2] S. Zallouz, C Ghimbeu *et al*., Applied Nano Materials, **4,** 5022 (2021).
[3] A. Triolo *et al.*, J. Phys. Chem. B **110**, 1513 (2006).