Materials Science and Engineering Department

Spring Seminar Series

Electrochemistry at the nanoscale: application to materials for energy storage

Prof. Patrice Simon
Department of Materials Science
Paul Sabatier University, France

April 20, 2022 | 2-3PM

Zoom Link: https://drexel.zoom.us/j/88592537031

In the past decade, lot of attention has been put on the synthesis and characterizations of materials for electrochemical energy storage devices such as batteries and double layer capacitors (supercapacitors). Batteries provide high energy density - small amounts of energy for a long time -, and double-layer capacitors provide high power - fast energy delivery. Blending both features into one electrochemical energy storage system would allow for fast charging and energy harvesting and would transform our lives by allowing proliferation of energy storage devices into all spheres of human activities.

During this presentation, we will show how the careful design of nanostructured carbons can help in preparing high energy density carbons for supercapacitor applications. The combination of several techniques like Electrochemical Quartz Crystal Microbalance (EQCM), X-Ray scattering and simulations has then been used for studying the ion confinement effect in carbon nanopores and the associated charge storage increase. These results helped in developing our basic understanding of the ions/carbon interactions in confined pores. From a practical point of view, they open new paths for designing high energy density supercapacitors. Moving from double layer to battery-like redox materials, we will show how the control of the electrodes structure can help in preparing electrodes with high capacity and high charge / discharge rate using 2-Dimensional MXene materials in non-aqueous electrolytes.

Finally, we suggest that understanding of electrosorption under confinement in porous and layered materials that results in improved electrochemical performance could be explained by the electrolyte ion partial desolvation observed when confined in nanopores (porous carbons) or in interlayer spacing (2D materials) [5]. Understanding confined electrochemical systems and coupling between chemical, electrochemical, and transport processes in confinement may open tremendous opportunities for energy applications in the future.

Patrice Simon is Distinguished Professor of Material Science at the Université Toulouse III - Paul Sabatier and member of the French Academy of Sciences (2019). He is former director of the Alistore European Research Institute (www.alistore.eu) dedicated to Li-ion battery research and Deputy Director of the French network on Electrochemical Energy Storage (RS2E, www.energie-rs2e.com). His research activities focus on the fundamental understanding of electrochemical processes occurring at the material / electrolyte interfaces in electrodes for electrochemical energy storage devices (batteries and electrochemical capacitors). He published about 250 papers (h-index 84, 63,000 citations). He received several awards for his scientific contribution including Grants from the European Research Council (2012, 2020), Conway Prize in Electrochemistry from ISE (2018), the Silver Medal from the CNRS (2015), International RussNanoprize (2015). He is Fellow of the nternational Society of Electrochemistry (2017). Patrice Simon is member of the European Academy of Sciences (2019), member of the French Academy of Technologies (2018) and Senior Member of the Institut Universitaire de France (2017).

DREXEL UNIVERSITY
College of
Engineering

FOR MORE INFORMATION

Email: kn52@drexel.edu

drexel.edu/materials