Title: Real-time charge storage in energy storage devices

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School: School of Chemical Engineering

Faculty Research Area: Energy Systems, Renewable and Non-Renewable

School Research Area: Energy

Project description:

Understanding real-time charge transport is critical for energy storage devices such as supercapacitors and batteries to better utilize renewable energy. At the moment, Electrochemical Quartz Crystal Microbalance (EQCM) is used as a powerful technique for this purpose. EQCM measures the shift in resonant frequency of quartz crystals, which can then be correlated to the mass change on the surface. As such, the amount of ions inserted into or departed from the electrodes can be probed at a high sensitivity, down to ~1 ng. EQCM has been commonly applied in supercapacitors with aqueous electrolytes (i.e., water-based). However, little is known for "water-in-salt" electrolyte, which is a new type of electrolyte with a very high ionic concentration and high viscosity. The "water-in-salt" electrolyte has become an important ingredient for developing high-potential, safe, environmentally-friendly energy storage devices.

Research Environment:

The student will have the opportunity to work in a highly prolific team in the PartCat Research Group at School of Chemical Engineering, under the guidance of Dr Zhaojun Han and Dr Xunyu Lu. He/she will also have the opportunity to interact with Sci. Prof. Rose Amal, director of the PartCat Research Group. In addition, the student could be affiliated with CSRIO, Australia's national research agency, and have access to industry-focused research environment.

Novelty and Contribution:

This project aims to use EQCM to study real-time charge storage in the "water-in-salt" electrolyte. Because of high viscosity, an additional factor will be considered to correct the current formula used for aqueous solution. This will contribute to new understanding in energy storage devices.

Expected Outcomes:

The work of this project will include i) preparation of "water-in-salt" electrolyte, ii) fabrication of graphene-based supercapacitor electrodes, iii) operation of EQCM, and iv) interpretation of electrochemical data. At the end of the project, the student is expected to obtain basic knowledge in charge storage mechanism of supercapacitors, hands-on experience in fabrication and testing, and new understanding of a range of electrochemical energy storage devices.

Reference Material Links:

[1] M. D. Levi, N. Levy, S. Sigalov, G. Salitra, D. Aurbach, J. Maier, Electrochemical Quartz Crystal Microbalance (EQCM) Studies of Ions and Solvents Insertion into Highly Porous Activated Carbons, *J. Am. Chem. Soc.* **2010**, *132*, 13220.

[2] W.-Y. Tsai, P.-L. Taberna, P. Simon, Electrochemical Quartz Crystal Microbalance (EQCM) Study of Ion Dynamics in Nanoporous Carbons, *J. Am. Chem. Soc.* **2014**, *136*, 8722.

Linking to undergraduate curriculum: