4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Micro-supercapacitor electrodes based on hydrous ruthenium oxide and highly porous Au current collectors: the recipe for High Areal Capacitance

Daniel Guay,[1]* Anaïs Ferris,[1,2,3] Sébastien Garbarino,[1] David Pech,[2,3]

[1]*INRS-EMT, 1650, boulevard Lionel-Boulet, Varennes (Québec) J3X 1S2, Canada*
[2]*CNRS, LAAS, 7 avenue du colonel Roche, F-31400 Toulouse, France*
[3]*Univ de Toulouse, LAAS, F-31400 Toulouse, France*

Accepted for publication on 28th February 2015

The increasing importance of portable and wearable devices incorporating more advanced electronic technologies, as well as the future deployment of wireless sensor networks embedded in our everyday environment has made on-board energy storage a critical issue. In the last decade, the integration of miniaturized electrochemical capacitors (also called supercapacitors) on circuit chips has been the subject of intense research on the account of their excellent charge–discharge rate and long operating life time [2–7]. Although ultrahigh-power micro-sized supercapacitors have been reported, they still suffer from low energy density that remains far from Li-ion micro-batteries. A significant improvement of their volumetric/areal energy density is needed for more challenging applications.

In this presentation, we will present our most recent attempts to increase the areal capacitance of electrodes by relying on hydrous ruthenium oxide deposited onto a highly porous Au current collector. For this purpose, an Au thin film was first formed by electroplating from a gold ions containing solution under conditions (large negative potential) where hydrogen evolution occurs simultaneously. In these conditions, hydrogen bubbles are formed and left the electrode surface creating a hydrogen bubble dynamic template. Under the optimal deposition conditions, the roughness factor of the Au thin film, R_f, which is the ratio between the extended surface area of Au with respect to the geometrical surface area, reaches value as large as 145. This highly porous Au electrode is then used as a substrate to electrodeposit ruthenium oxide. As it will be demonstrated, deposition of ruthenium oxide occurs throughout the entire thickness of the Au porous network without blocking access to the finest pores. The resulting electrode exhibits an unprecedented high areal capacitance, in excess of 1 F/cm². Such porous gold/ruthenium oxide hybrid structure electrode provides an interesting alternative for integration of high-energy micro-supercapacitors onto silicon chips.

Keywords: porous Au electrode, ruthenium oxide, electrodeposition, high surface area, capacitance