

## Electrochemically Deposited Phosphotungstic Acid – Manganese Dioxide Hybrid Materials for Application in Electrochemical Capacitors

Andrew J. Gibson, Robert C. Burns and Scott W. Donne

Discipline of Chemistry, University of Newcastle,  
Callaghan NSW 2308, Australia

([scott.donne@newcastle.edu.au](mailto:scott.donne@newcastle.edu.au))

Manganese dioxide is used in electrochemical capacitors due to its low toxicity and cost, combined with its good pseudocapacitive behaviour [1]. Polyoxometalates in different forms have been used to improve the charge storage ability of capacitor materials such as conducting polymers and activated carbons, as polyoxometalates are able to undergo multiple, fast, reversible reduction steps [2]. Investigating the inclusion of polyoxometalates in a material which has been shown to have a high specific capacitance has the potential to lead to better materials.

The pseudocapacitive behavior of materials can be increased by modifying the surface structure such that the number of redox active sites, or the number of sites for so-called underpotential deposition is increased relative to surface area. The capacitive behavior of a material can also be increased by increasing the specific surface area directly.

In this study,  $\text{MnO}_2$  was deposited from a solution of 0.01 M  $\text{MnSO}_4$  and 0 – 0.008 M  $\text{H}_3\text{PW}_{12}\text{O}_{40}$  (PW) in 0.1 M  $\text{H}_2\text{SO}_4$  at a potential of 1.2 V (vs. SCE) onto a Pt electrode. The materials synthesised were investigated for capacitive behaviour using cyclic voltammetry, and for polyoxometalate inclusion using a quartz crystal microbalance. Figure 1 shows some of the results obtained from the EQCM analysis, where a clear increase in the theoretical mass, however a clear decrease in total mass deposited with respect to time can be seen. Results from this investigation will be described and discussed.

[1] A. D. Cross, A. Morel, T. F. Hollenkamp, S.W. Donne, *Journal of the Electrochemical Society*, **158**, A1160 – A 1165, 2011.

[2] T. Akter, K. Hu, K. Lian, *Electrochimica Acta*, **56**, 4966 – 4971, 2011.

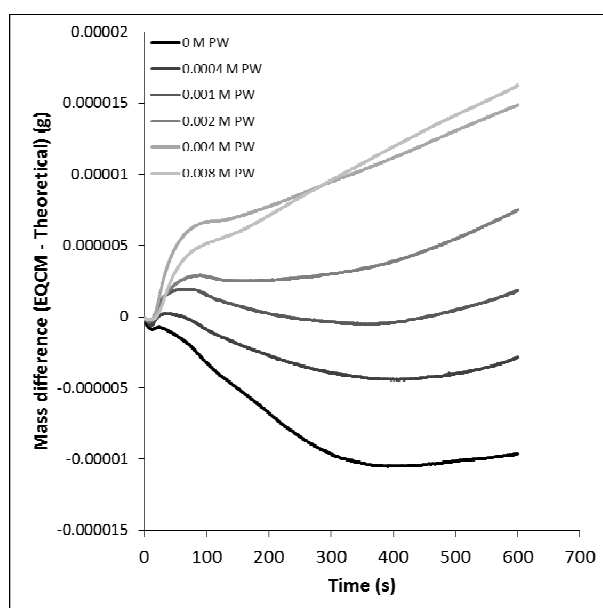
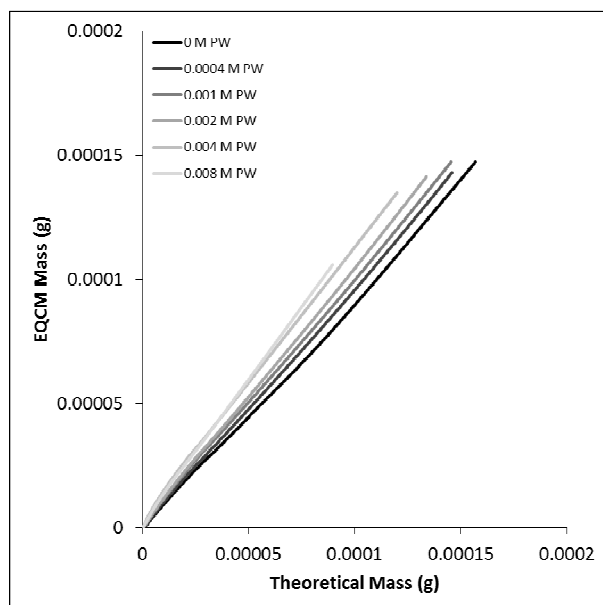


Figure 1: (top) EQCM recorded mass versus theoretical mass during a 10 minute deposition experiment. (bottom) Difference in mass between the EQCM and calculated theoretical as a function of deposition time.