

Correlating electrochemical and spectroscopic ellipsometry signals to evaluate energy storage interfaces

Eric J. Dufek^{*}, Lucia M. Petkovic
Idaho National Laboratory
Idaho Falls, ID 83415

Interfacial characteristics of energy storage electrodes are key drivers for performance. Among the crucial components are the films present as part of the electrode. First is the surface electrolyte interphase (SEI) which forms during cycling on battery electrodes. As electrolyte is reduced, a series of insoluble and semi-soluble products are generated. Thus, SEI formation is dictated, in part, by the electrolyte components and their differing reduction potentials.(1) A second crucial film component is binders which enable composite electrodes to remain as laminates. Recent work has shown that varying the binder material provides a means to significantly alter the performance of active materials.(2, 3)

The use of complimentary methods to evaluate materials provides the opportunity to more thoroughly understand the mechanism by which changes in performance occur. This presentation will focus on the nature of interfacial films including the SEI and binders using electrochemical, spectroscopic ellipsometry and vibrational spectroscopy to more fully elucidate the role played by different components of electrolyte and different binder components with an emphasis placed on method development to more thoroughly characterize and compare the abundance of new materials which are presently being developed.

Spectroscopic ellipsometry provides a means to follow film growth and dissolution *in situ* during cycling of a cell. Thus, upon close analysis, it becomes possible to follow and correlate stability changes in films such as the SEI with electrochemical processes. A key focus of the presented work will be on path dependence of SEI formation and stability and the role that different electrolyte components and additives play in stabilizing the SEI. Preliminary analysis indicates it is possible to model SEI growth and dissolution as a multi-component system and to follow the growth and dissolution of the overall film components while correlating each with an electrochemical process. Knowledge of the role of the SEI creates the possibility to more effectively follow changes in other composite electrode components including binders during both active cycling and during rest.

Acknowledgements

Work supported through the INL Laboratory Directed Research and Development (LDRD) Program under DOE Idaho Operations Office. This manuscript has been authored by Battelle Energy Alliance, LLC under Contract No. DE-AC07-05ID14517 with the U.S. Department of Energy. The United States Government retains and the publisher, by accepting the article for publication, acknowledges that the United States Government retains a nonexclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this manuscript, or allow others to do so, for United States Government purposes.

^{*}Email: Eric.Dufek@inl.gov

1. D. Aurbach, M. Moshkovich, Y. Cohen and A. Schechter, *Langmuir*, **15**, 2947 (1999).
2. S. Komaba, N. Yabuuchi, T. Ozeki, Z. J. Han, K. Shimomura, H. Yui, Y. Katayama and T. Miura, *Journal of Physical Chemistry C*, **116**, 1380 (2012).
3. J. Li, D. B. Le, P. P. Ferguson and J. R. Dahn, *Electrochimica Acta*, **55**, 2991 (2010).