Toward Efficiently Rechargeable Li-O_2 Batteries Utilizing Lithium Nitrate Based Electrolytes.

W. Walker, V. Giordani, V. S. Bryantsev, J. Uddin, G. V. Chase, D. Addison

Liox Power, Inc.
129 N. Hill Ave., Suite 103, Pasadena, CA 91106, USA
Email: Wes@liox.com

A major challenge in the development of rechargeable Li-O_2 batteries is the identification of materials that are stable in the operating environment of the O_2 electrode. Degradation during cycling of every major cell component, including solvent, lithium salt and carbon cathode, has plagued efforts to develop this technology for practical applications.[1-8] Therefore, the time has come to move away from components utilized in most successful Li-ion batteries and consider a larger universe of materials.

This presentation will focus on research conducted at LIOX Power involving the use of lithium nitrate based electrolytes. This will include successful cycling of a Li-O_2 battery containing an electrolyte consisting of N,N-Dimethylacetamide (DMA) and lithium nitrate ($LiNO_3$) shown to cycle at a rate of 0.1 mA/cm^2 for more than 2000 hours (>80 cycles) with a consistent charging profile, good capacity retention and O_2 detected as the primary gaseous product formed during charging.[9] Additionally, in depth analysis of the effect of $LiNO_3$ on the lithium anode will be presented and show a synergistic effect of dissolved O_2 and the nitrate anion on the formation of a stable SEI between Li metal and the solvent.

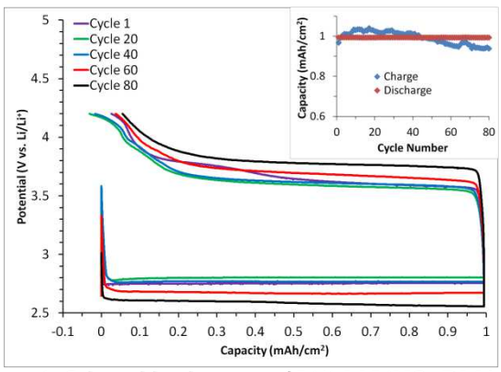

Figure 1: Selected load curves of Li/1 M $LiNO_3$ DMA (150 µL)/Csp, RT, 0.1 mA/cm^2 with charge/discharge capacity inset.

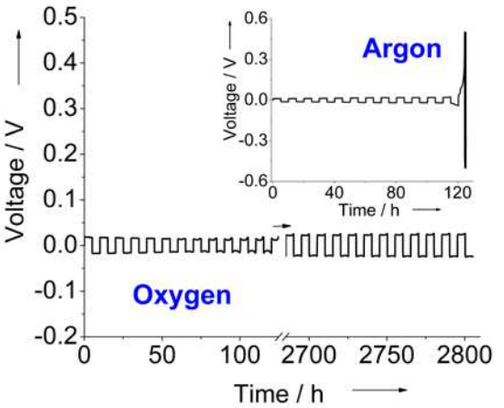

Figure 2 Voltage profile (first and last 100 hours) of a symmetric Li/Li cell cycled in 1 M $LiNO_3$-DMA electrolyte under O_2. Inset: Voltage profile of a symmetric Li/Li cell cycled in 1 M $LiNO_3$-DMA electrolyte under Ar. Current density: 0.2 mA/cm^2. Li deposition/dissolution limited to 5 h per half cycle.

References

1) Freunberger, S; Chen, Y; Peng , P; Bruce, P. *J. Am. Chem. Soc.* 2011, 133, 8040.
2) Freunberger, S; Chen, Y; Drewett, N; Hardwick, L; Bardé, F; Bruce, P. *Angew. Chem. Int. Ed.* 2011, 50, 8609.
3) Bryantsev, V; Giordani, V; Walker, W; Blanco, M; Zecevic, S; Uddin, J; Addison, D; Chase, G. *J. Phys. Chem. A.* 2011, 115, 12399.
4) Veith, G; Nanda, J; Delmau, L; Dudney, N. *J. Phys. Chem. Lett.* 2012, 3, 1242.
5) Black, R; Oh, S; Lee, J; Yim, T; Adams, B; Nazar, L. *J. Am. Chem. Soc.* 2012, 134, 2902.
6) McCloskey, B; Speidel, A; Scheffler, R; Miller, D; Viswanathan, V; Hummelshøj, J; Norskov, J; Luntz, A. *J. Phys. Chem. Lett.* 2012, 3, 997.
7) Bryantsev, V; Uddin, J; Giordani, V; Walker, W; Addison, D; Chase, G. *J. Electrochem. Soc.* in press.
8) McCloskey, B; Speidel, A; Scheffler, R; Miller, D; Viswanathan, V; Hummelshoj, J; Norskov, J; Luntz, A. *J. Phys. Chem. Lett.*, 2012, *3* (8), pp 997–1001.
9) Walker, W. Giordani, V. Uddin, J. Bryantsev, V.S. Chase, G. V. Addison, D. *J.Am.Chem.Soc.*2013, *135* 2076-2079.