Abstract #508, 224th ECS Meeting, © 2013 The Electrochemical Society

Bis(oxalato)borate containing solid polymer electrolytes for lithium metal batteries

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The demand on energy is actually only maintainable by the massive use of fossil energy sources. The foreseen lack on fossil fuels could lead to various limitations in the future technological progress. Accessing more and more renewable energy reveals the necessity for high capacity energy storage systems. Among the battery systems lithium air promises a solution, due to its high theoretical energy density (11.680 $Wh \cdot kg^{-1}$), which is close to the one of gasoline (13.000 $Wh \cdot kg^{-1}$).[1]

In lithium air batteries a lithium metal anode is combined with an electrolyte and a porous carbon cathode. Discharging the cell reduces oxygen from the air in the carbon cathode and oxidizes the metallic lithium anode.[2]

$$2\,Li + O_2 \rightleftarrows Li_2O_2$$

According to the type of electrolyte used, lithium air batteries can be distinguished into four groups (aprotic, aqueous, solid state, hybrid (aprotic / protic)).[1]

Safety issues prevented lithium metal secondary batteries from commercial launch so far. Lithium metal tends to form dendrites during charge, which can cause an internal short circuit of the cell and leads to thermal runaway. Also water from the ambient atmosphere can react violently with the metallic lithium anode. Protecting the metallic lithium against moisture and suppressing dendrite formation therefor have high priority. Solid electrolyte systems combine the properties of an electrolyte and a separator. In these systems high lithium ion conductivity combined with low gas and water diffusion rates is needed. Figure 1 shows a ternary solid polymer electrolyte (SPE) consisting of *poly(ethylene oxide)*, *lithium bis(oxalato)borate* and *N-butyl-N-methylpyrrolidinium bis(oxalato)borate*.

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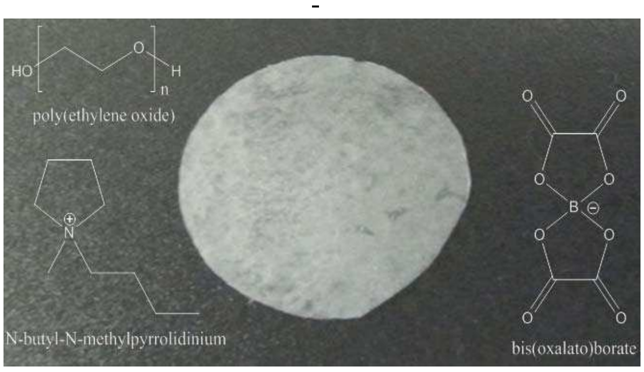

Figure 1: *Bis(oxalato)borate* containing solid polymer electrolyte.

In this work we will introduce SPEs with different molar fractions of *bis(oxalato)borate* and a thickness of 50-200 µm, designed for the use in lithium metal batteries. These polymer electrolytes will be compared to *bis((trifluoromethyl)sulfonyl)imide* anion containing SPEs in respect of thermal stability (differential scanning calometry), conductivity (impedance spectroscopy) and electrochemical stability (linear sweep voltammetry).[3]

[1] G. Girishkumar, B. McCloskey, A.C. Luntz, S. Swanson, W. Wilcke, *J. Phys. Chem. Lett.*, **1**, (2010), 2193-2203.

[2] R. Padbury, X. Zhang, *J. Power Sources*, **196**, (2011), 4436-4444.

[3] G.T. Kim, G.B. Appetecchi, M. Carewska, M. Joost, A. Balducci, M. Winter, S. Passerini, *J. Power Sources,* **195**, (2010), 6130-6137.