

Study of the Corrosion Behavior of LiFSI Based Electrolyte for Li-Ion Cells

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Abstract

In coin and pouch cell setups, the corrosion/passivation phenomenon of Al and stainless steel with 1.25 M LiFSI in ethylene carbonate / ethyl methyl carbonate 30/70 wt percent electrolyte was investigated. The LiFSI electrolyte may passivate Al foil in the usual cell operation voltage window of 2.8 to 4.3 V, according to the results. In a cyclic voltammetry test, however, no passivation behaviour was found for stainless steel with an ever-increasing current response. Corrosion is a term that refers to the process of corrosion. Fe/Cr ions were discovered on the anode side, which accelerated the electrolyte degradation mechanism. In a 1.5 Ah pouch cell, the LiFSI electrolyte was put to the test for long-term cycling and quick charging. After 1000 cycles, capacity retention was 88.5 percent at 1C and 80 percent for extreme rapid charging rates, demonstrating the applicability of LiFSI in Li-ion cells without stainless steel components.

Keywords: Cyclic volumetric test; Electrolyte; Corrosion

Introduction

Electrolyte development is critical for Li-ion batteries to achieve high voltage, high energy density, extended cycle life, and quick charging. The skeletal composition of LiPF_6 salt in organic carbonate solvents has dominated the state-of-the-art electrolyte. Because of its high conductivity in solution and acceptable safety features, LiPF_6 was chosen. At moderately high temperatures, LiPF_6 is thermally instable and decomposes. It's also quite susceptible to moisture, which causes HF which has negative consequences for performance and safety. New Li salts have been developed in order to boost the electrochemical performance of the electrolyte even further. The strong electron-withdrawing characteristic of lithium imides has piqued people's interest. LiFSI has been discovered as a potential contender in lithium imide salts due to its better solubility, ionic conductivity, and thermal stability when compared to LiPF_6 . The pure LiFSI salt showed superior stability towards hydrolysis than LiPF_6 , and a higher conductivity in EC/EMC mixture compared to LiPF_6 . Later, the same group demonstrated LiFSI has higher thermal stability and higher Li ion transference number than LiPF_6 , the ability of LiFSI to passivate aluminum (cathode current collector) remains in argument. Corrosion can affect significantly on battery performance. LiFSI, on the other hand, has been found to have better anticorrosive effects against Al in various studies discovered that there was no significant corrosion on the Al surface, and that Al passivation was achieved in 1.0 M LiFSI in a high-purity carbonate electrolyte by lowering free chlorines. Because of the disparity in the literature, the corrosion study for LiFSI electrolyte should be revisited. We discovered that Al can be passivated with high purity LiFSI electrolyte in this study, but that corrosion of stainless steel (SS) cell parts is severe. Using a VSP potentiostat, cyclic voltammetry was performed at 0.1 mV/s with various voltage windows. Two alternative cell

formats were used for the measurement: 2032 coin cell and pouch cell. Al or SS foils were used to make the working electrodes. It depicts the coin cell and pouch cell configurations. The working electrode in a conventional coin cell is Al foil, while the cell pieces are made of stainless steel. The pouch bag was manufactured from Al laminated film with polypropylene as the inner layer in the pouch cell form. The working electrodes in the pouch cell for the CV test were Al foil and SS foil. At the same time, a Tafel polarisation test was carried out. Using the Tafel-extrapolation method in EC-lab software, the corrosion current and potential were calculated. XPS characterization of the product after CV corrosion test was conducted on a PHI Versa Probe scanning XPS microscope, with monochromatic Al K-alpha X-ray source (1486.6 eV). Samples were prepared in an Ar-filled glove box. The electrodes were washed three times with dimethyl carbonate before being moved via a transfer tank to the XPS ultra-high vacuum chamber. With 200 m/50 W/15 kV X-ray settings and dual-beam charge neutralisation, XPS spectra were obtained. With Al foil as the working electrode and Li foil as the counter electrode, CV was performed in a typical coin cell configuration. LiFSI or LiPF₆ electrolyte were used to fill the cells. Both electrolytes have a water concentration of 25 ppm, according to Karl Fischer titration. LiFSI electrolyte, significant oxidation current was observed above 4.0 V in the 1st cycle. This can be ascribed to pitting corrosion behavior, similar to observation. In subsequent cycles, the current equivalent to corrosion increases even more. The voltage at which current begins to grow moves to lower voltages as well. This suggests that the LiFSI electrolyte was unable to passivate the coin cells' metal. Electrolytes containing LiFSI salt were shown to have passivation towards the Al current collector, and their current response behaviour in CV tests was comparable to that of LiPF₆ electrolytes. When SS parts/electrodes were included in the cell, a large current response was found in a CV test of LiFSI electrolyte. Inside the cells containing SS parts/electrodes, a black reaction product was noticed. XPS studies confirmed that the dark product's composition is due to electrolyte decomposition. The most likely explanation is that Fe/Cr ions from the corrosion reaction accumulated on the anode surface, speeding up the electrolyte breakdown. Capacity retention was 93% after 400 cycles at C/3, 88.5 % after 1000 cycles at 1C, and 80 percent after 1000 cycles at XFC rates, indicating good cycling performance. When SS cell pieces are removed, the results show that a LiFSI-based electrolyte is viable for Li-ion cells.