Recent Development of ENEA Lithium Metal Battery Project

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Introduction

A common approach to enhance the conductivity of PEO polymer electrolytes is the use of a lithium salt having a very large counter-ion which is able to interfere with the crystallization process of the polymer chains,\(^1\) thereby promoting amorphous regions and increasing the lithium ion transport in the polymer electrolyte.\(^2,3\) Following this approach, we have shown that the use of a large anion \(\text{NSO}^{	ext{(CF}_{2}\text{CF}_{2})_2}\) (BETI) lithium salt enhances the conductivity of PEO-based polymer electrolytes.\(^4\) In this scenario, we decided to investigate the feasibility of PEO-LiBETI electrolytes in Li/V\(_2\)O\(_5\) polymer battery prototypes having capacities ranging from 0.5 to 1 Ah.

Experimental

PEO-LiBETI polymer electrolyte films were prepared by a completely dry, solvent-free procedure developed at ENEA.\(^5,6\)

The V\(_2\)O\(_5\)-based composite cathodes were prepared by following a procedure developed at ENEA\(^7\) and industrially scaled-up by Ferrania S.p.A.

The Li/PEO-LiBETI/V\(_2\)O\(_5\) prototypes are formed by a stack of ten bipolar cells connected in parallel. The final devices, housed in sealed coffee-bag envelopes under vacuum, were realized by laminating ten cathode tapes, eleven lithium foils and twenty polymer electrolyte layers.

Results

In Figure 1 is plotted the voltage/capacity profile of two Li/PEO-LiBETI/V\(_2\)O\(_5\) battery prototypes held at 90°C during the first discharge/charge cycle. A capacity of 0.8 Ah (2.75 equivalent of Li per mole of V\(_2\)O\(_5\)) was delivered in the initial discharge while 82% of the lithium inserted, i.e., 0.66 Ah, was recovered.

The discharge capacity vs. current density dependence for two Li/PEO-LiBETI/V\(_2\)O\(_5\) battery prototypes held at 90°C is reported in Figure 2. The prototypes are capable to deliver more than 85% of full capacity up to 0.5 m\(\text{Acm}^{-2}\) (C/3.7). Above 50% and 20% of reversible capacity is still delivered at 1.0 m\(\text{Acm}^{-2}\) (C/1.9) and 2.0 m\(\text{Acm}^{-2}\) (1.1C), respectively.

The results demonstrated clearly the feasibility and reproducibility of the Li/V\(_2\)O\(_5\) polymer battery prototypes.

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References


![Figure 1](Image 315x323 to 538x469)

**Figure 1.** Voltage/capacity profile of two Li/PEO-LiBETI/V\(_2\)O\(_5\) battery prototypes held at 90°C during the first discharge/charge cycle.

![Figure 2](Image 315x515 to 538x683)

**Figure 2.** Discharge capacity, reported as percent of reversible capacity, vs. current density plot of two Li/PEO-LiBETI/V\(_2\)O\(_5\) battery prototypes held at 90°C. The discharge rates are also reported. Charge current density: 0.2 m\(\text{Acm}^{-2}\).