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.[2-4] Following this approach, we have shown that the use of a large anion $N(SO_2CF_2CF_3)_2^-$ (BETI) lithium salt enhances the conductivity of PEO-based polymer electrolytes.[5] In this scenario, we decided to investigate the feasibility of PEO-LiBETI electrolytes in Li/V_2O_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.[6,7]

The V_2O_5-based composite cathodes were prepared by following a procedure developed at ENEA[8] and industrially scaled-up by Ferrania S.p.A.

The Li/PEO-LiBETI/V_2O_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_2O_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_2O_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_2O_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 mAcm^{-2} (C/3.7). Above 50% and 20% of reversible capacity is still delivered at 1.0 mAcm^{-2} (C/1.9) and 2.0 mAcm^{-2} (1.1C), respectively.

The results demonstrated clearly the feasibility and reproducibility of the Li/V_2O_5 polymer battery prototypes.

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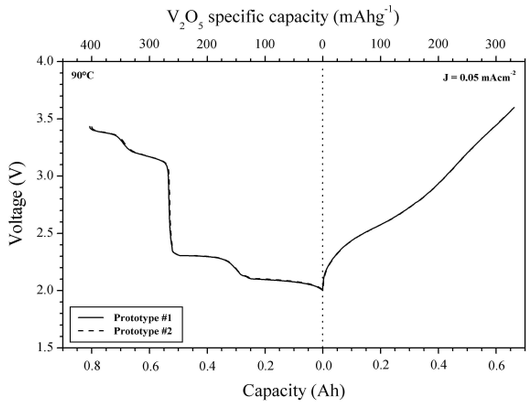

Figure 1. *Voltage/capacity profile of two Li/PEO-LiBETI/V_2O_5 battery prototypes held at 90°C during the first discharge/charge cycle.*

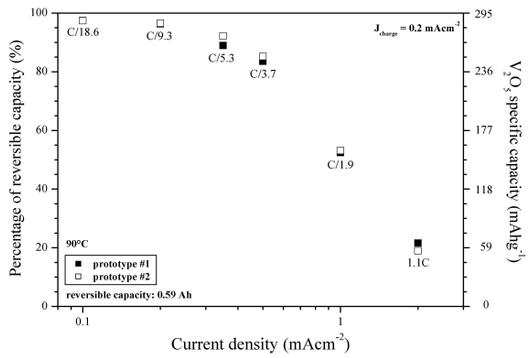

Figure 2. *Discharge capacity, reported as percent of reversible capacity, vs. current density plot of two Li/PEO-LiBETI/V_2O_5 battery prototypes held at 90°C. The discharge rates are also reported. Charge current density: 0.2 mAcm^{-2}.*