

### Current Collector Materials for Li-ion Positive Electrodes

Adam H. Whitehead, Ali Shefa, Tomislav Balvanovic,  
Martha Schreiber\*

Funktionswerkstoffe F & E GmbH  
Eisenstadt, A-7000 Austria  
\* EN-o-DE

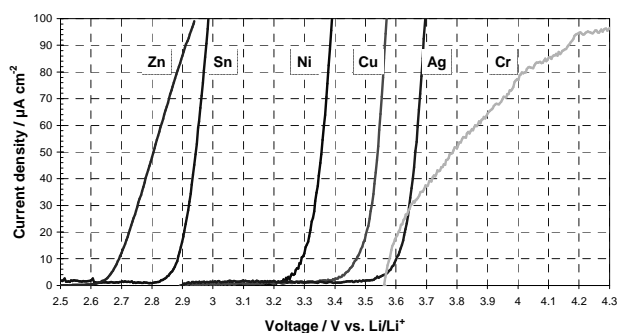
Energy on Demand Production and Sales GmbH  
Eisenstadt, A-7000 Austria

Aluminium foil is the present material of choice for Li-ion positive electrode current collectors. Aluminium is a relatively inexpensive, widely available and electrochemically stable material, but cannot easily be used to prepare structured, three-dimensional current collectors. The foils are themselves very thin and liable to creasing and tearing if not handled with great care.

The advantages of three-dimensional current collectors, prepared by metallizing a polymer fabric, have already been explained<sup>[1, 2]</sup>. They include flexibility, toughness, ease of handling and increased performance of electroactive components. It has also been demonstrated that flexible, three-dimensional current collectors for negative electrodes may be prepared by coating a woven polymer support with a thin layer of copper in an electroless plating process. However, the problem of preparing a similar current collector for the positive electrode remained unsolved.

In order to address this problem a review of materials used previously as positive current collectors was carried out. Many of these materials were unsuitable for electroless plating (such as tungsten or stainless steel) or too expensive to be considered for wide-scale application (such as platinum). The remaining materials were examined experimentally for stability in Li-ion battery electrolytes, e.g. 1 M LiClO<sub>4</sub> in a 1:1 mixture of ethylene carbonate: propylene carbonate (EC: PC), by slow potential sweep. In practice a small sample of the test material (1 cm<sup>2</sup> area) was placed in a coin cell with a lithium foil counter electrode, non-aqueous electrolyte and microporous, polyolefin separator. The potential was then ramped at 200  $\mu\text{V s}^{-1}$  from the open-circuit voltage to 4.3 V or until the current density exceeded 100  $\mu\text{A cm}^{-2}$ , depending on which occurred first.

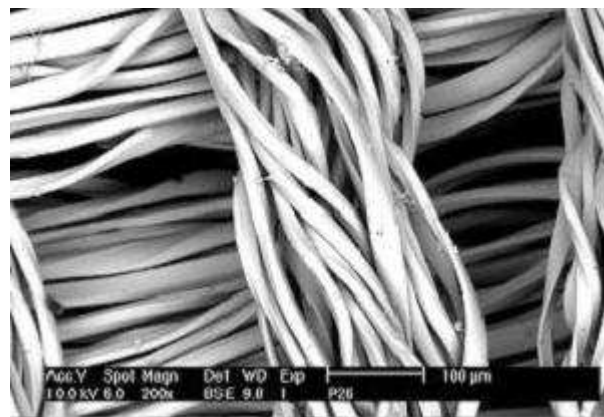
Sweeping the potential revealed that in general materials which were easily plated from aqueous solution were also rather easily stripped in the potential range of many standard positive electrode materials (up to 4.3 V vs. Li/Li<sup>+</sup>):



**Figure 1** - potential sweep of various potential current collector materials for the positive electrode in EC/ PC/ LiClO<sub>4</sub> at 0.2 mV s<sup>-1</sup>

Because none of the previously reported materials, that could be easily plated from aqueous solution, were found to be suitable a further series of materials were investigated, namely the Ni-P alloys.

Ni-P alloys of varying compositions were prepared by a wide range of electroless plating baths - based on standard mixtures. The alloys were coated onto woven polymeric fabrics (shown below):



**Figure 2** - scanning electron micrograph of a woven polymeric fabric coated with a Ni-P alloy.

The electrochemical stability and electrical resistivity of the alloy-coated fabrics were tested, and the composition determined from EDX measurements.

This work examines the effect of plating morphology, thickness and composition on the suitability of Ni-P alloys for positive current collectors in Li-ion batteries.

### Acknowledgements

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### References

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2. A. H. Whitehead and M. Schreiber, *ITE Lett. Batteries, New Technologies & Medicine*, **2** (4), 504 (2001).