NanoPoLiBat

Final Summary of the Project
NanoPoLiBat,
Contract NMP3-CT-2006-033195

Nanocomponents intregrated in rechargeable microbatteries (2006-2009)

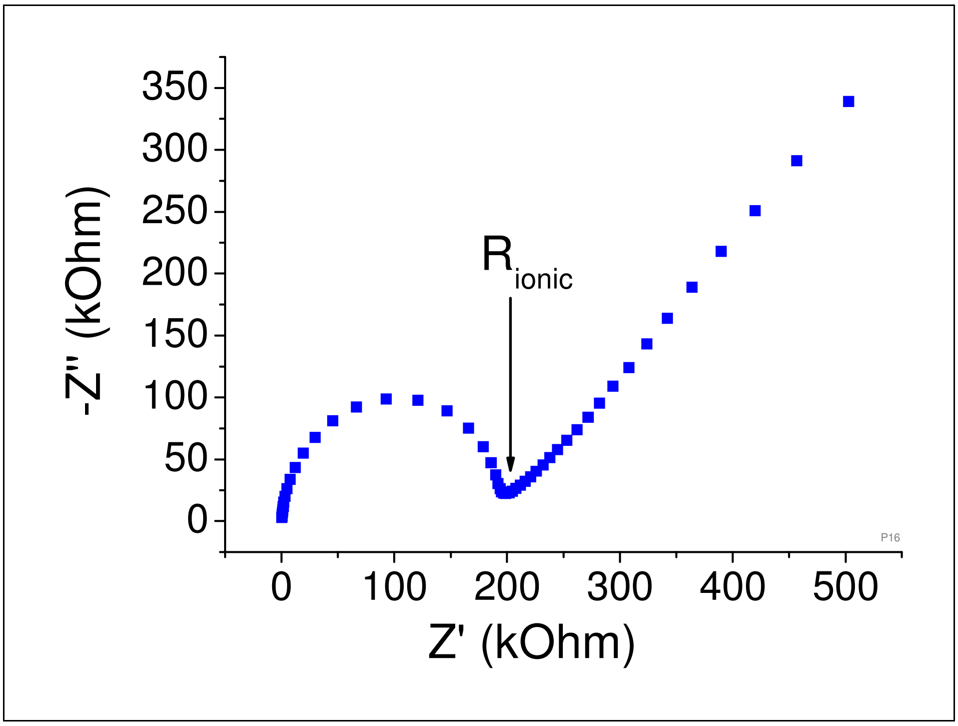
Nanomaterial combinations could provide the performance required for miniaturised battteries to store solar energy and power smart cards.

Nano-particulate electrode materials, electrode materials modified by surface layers in the nm range (core shell materials) and nano-structured composite electrodes and electrolytes all offer opportunities to overcome the limitations of current lithium polymer microbatteries. They reduce transport limitations within the materials, and decrease the over-potential required for intercalation /de-intercalation reactions of the Li-ions.

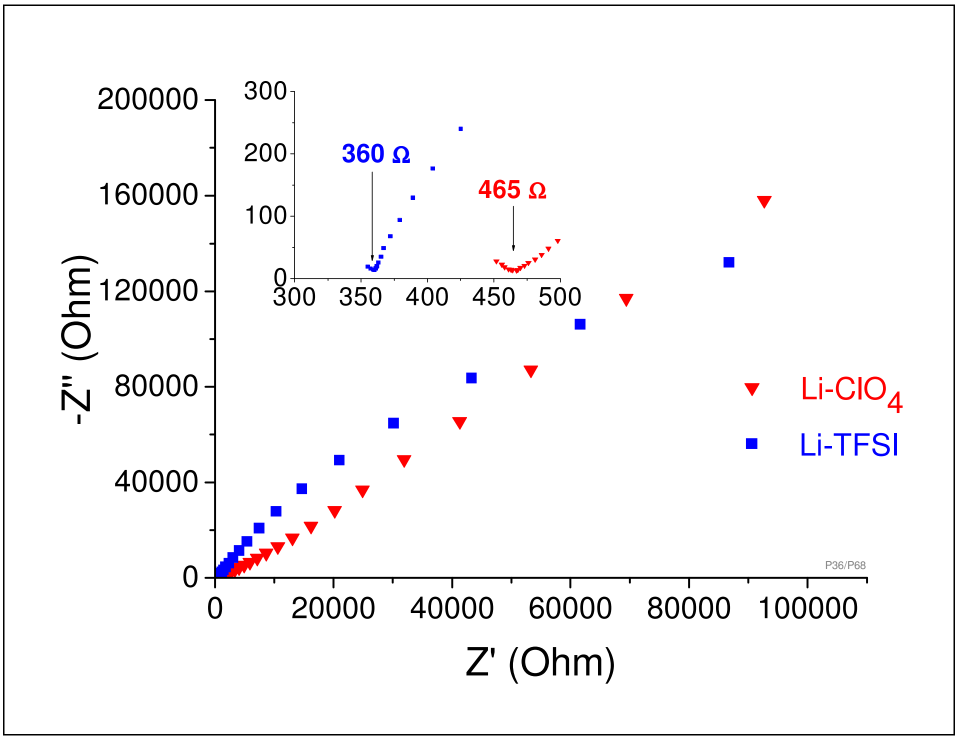
The NANOPOLIBAT project is engaged in the design and fine tuning of active materials, binders and separators for a very long life, high-rating rechargeable polymer Microbattery for low voltage applications. Intelligent composite electrodes require a well-designed spatial distribution of the various components, which cannot be achieved by simple mixing. The alternative being explored is the self-assembly of ano-particles on preconditioned surfaces.

- **Demonstrator for tomorrow´s technologies**

An advanced nano-ceramic / organic hybrid polymer (Ormocer®) combined with a promising new conductive salt is being used to produce a separator with high lithium-ion conductivity and adequate electrochemical stability. The hybrid is also applied as binder for electrode materials. The goal is to build up a battery with the newly developed nano-materials, in order to deliver a final demonstrator proving the concept for future technologies such solar energy storage and the powering of smart cards.



Typical impedance response of a gel polymer electrolyte ($\sigma \approx 3{\cdot}10^{-7}$ S/cm)



Impedance response of a polymer electrolyte system with different lithium salt:
(▼) lithium perchlorate ($LiClO_4$) (■) lithium trifluoromethansulfonimide (LiTFSI)
Inset: high frequency domain enlargement

❖ Project successes

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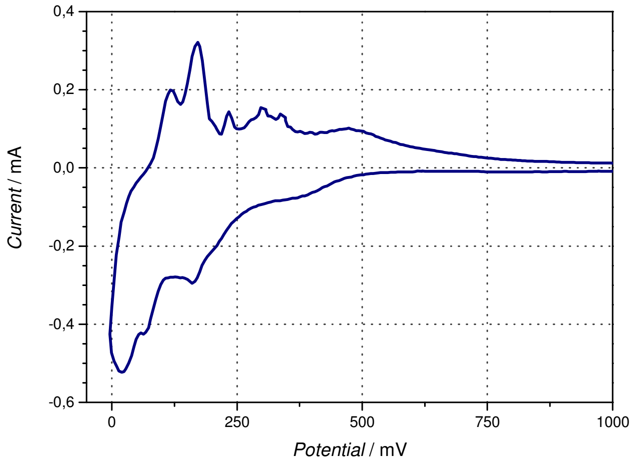
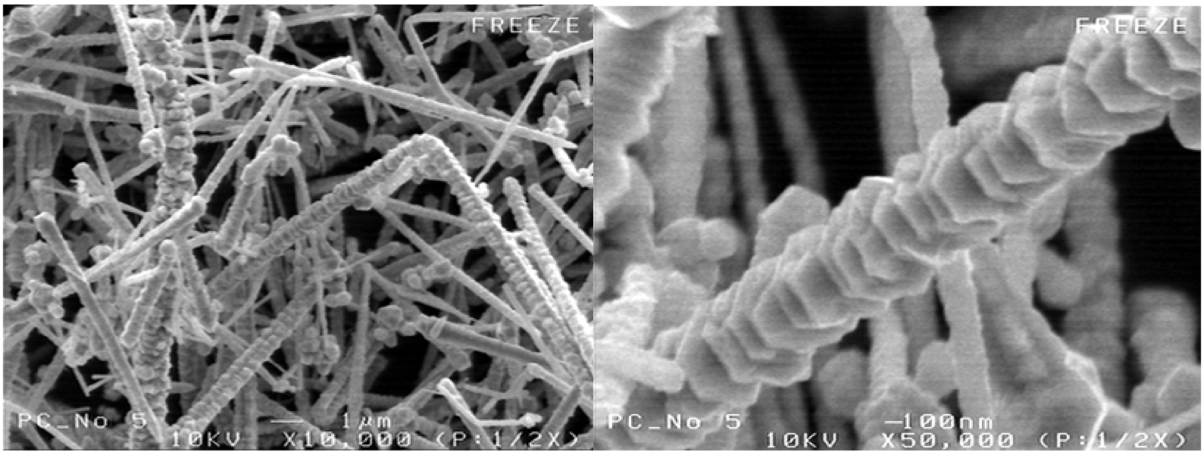
High-capacity blends. Nano-silicon / graphite blends that show higher capacities than standard graphite have been developed. I the opening year, a first sample containing 10% nano-Si was synthesised, showing a specific capacity of 600 mAh/g.



Cyclovoltammogramme of Si5H10 on graphite



SEM image of copper nano-wires - magnification: 10.000x and 50.000x

Higher capacity, safer electrodes. A study of the properties of Li-titanate ($Li_8Ti_5O_{13}$) as a cathode material is being carried out. This shows excellent capacity retention at various charge / discharge rates and temperatures, and is safer than other common electrode materials. In the form of nano-tubes and nano-fibres, it is characterised by extremely fast Lions-intercalation /de-intercalation.

Components tested. The conductivity of a polymer-salt complex electrolyte was measured at 10^{6} Scm^{3} at 25℃ and 6 x 10^{6} Scm^{3} at 80℃. Test were undertaken to measure the effect of plastization by a non-volatile tonic liquid on conductivity and battery performance. Samples of the ionic liquid were also made available to partners for testing with the li-titanate cathode material, nano-Si /C anode and Ormocer® based binder.

A first generation solvent-free polymer electrolyte gave conductivity of around $10^{5}Ohm^{3}cm^{3}$.

- **Conclusion**

A nano-Si /C-compound was successfully formulated. This invention was protected by a patent application.

From the three ways of making nano-TiO2 the best was chosen, but has to be improved in further projects.

The IL-electrolyte was improved significantly. The best of several candidates was formulated and characterized.

The combination of ORMOCER with the C-anode could not be used successfully. Further investigations are necessary.