

# Nanocomponents integrated in rechargeable microbatteries (2006-2009)

Nanomaterial combinations could provide the performance required for miniaturised batteries 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/deintercalation 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 micro-battery 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 nano-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.

## ☀ Project successes

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

**Higher capacity, safer electrodes.** A study of the properties of Li-titanate ( $\text{Li}_4\text{Ti}_5\text{O}_{13}$ ) 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 Li-ions-intercalation/deintercalation.

**Components tested.** The conductivity of a polymer-salt complex electrolyte was measured at  $10^{-6} \text{ Scm}^{-1}$  at 25°C and  $6 \times 10^{-3} \text{ Scm}^{-1}$  at 80°C. Tests were undertaken to measure the effect of plasticisation by a non-volatile ionic 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  $10^{-5} \text{ Ohm}^{-1} \text{ cm}^{-1}$ .



NMP3-CT-2003-33195 – **NANOPOLIBAT**  
Nanotechnology for advanced rechargeable polymer lithium batteries  
Total cost | € 2 228 586 – EC contribution | € 1 793 696  
Project duration | October 2006 – September 2009 (36 months)  
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