Nanotechnology to Improve Lithium-Ion Battery Storage Capacity

Supporting/Contributing Agency: National Reconnaissance Office

Power research and development efforts with the Rochester Institute of Technology NanoPower Research Labs are dedicated to the development of new materials and devices for power generation and storage. This R&D exploits the potential to gain a 3x increase in battery performance through the addition of single wall carbon nanotubes (SWCNT) in the anode, cathode, and carbonaceous materials of Lithium-Ion batteries. This breakthrough could enable a robust domestic industry for both space and automotive batteries.

The extraordinary mechanical, thermal, and electrical properties of carbon nanotubes and their related composite materials have prompted intense research into a wide range of applications. One such application, which has generated much interest throughout the space power community, is the possibility of their use as a replacement for the normal carbonaceous materials (e.g., graphite, carbon black, etc.) used in conventional lithium ion batteries. Advantages provided by single wall carbon nanotube battery components are increased depth of discharge; zero-volt state of charge; increased specific capacity; higher temperature operations (since no binder is in the electrode); and, flexible geometries.

R&D is focusing on improvements through the functionalization of carbon nanotube papers with many different nanomaterials. The table below shows the R&D goals:

Measure of Performance	Success Criteria
Charge Rate (C-Rate)	Exceed a 1C charge/discharge rate; i.e. fully charge/discharge the battery in less than one hour with at least 90% of the rated capacity
Energy Density	450 Whr/kg (or at least 3x performance of state of the art)
Cycle Life	50,000 charge/discharge cycles
Thermal Cycling	Operability from -55°C to +125°C
Storage Life	5 years

Figure 1 shows a scanning electron microscopy (SEM) of SWCNTs created by laser ablation at RIT. Figure 2 shows a SWCNT paper that is used to make an anode. Prototype batteries that will be field test in late 2009.

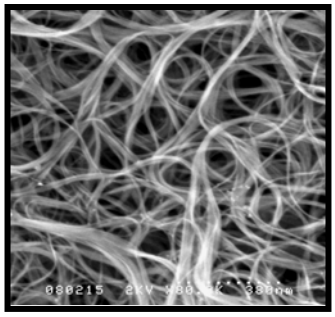

Figure 1. Single wall carbon nanotubes created by laser ablation at RIT

Figure 2. SWCNT paper that is used to make an anode

References/Publications

Landi, B.J., et al. *Journal of Nanoscience & Nanotechnology*., 2007, 7, 883-890.
B.J. Landi, et al. *Journal of Physical Chemistry B* 2005, 109, 9952.