Lithium Titanate Battery Technology – Bigger and Better

For a long time talk has swirled about the potential for Lithium-based batteries, in things as elementary as laptops and cellphones, to self-combust. This talk reached frenzy in recent times when the disappearance of Malaysian Airlines Flight 370 was initially attributed to some sort of problem with its cargo of lithium batteries. As time has gone on this theory has been discarded to be replaced by pilot misdemeanor. However the concerns about lithium batteries spontaneously overheating, even when not in use have not gone away.

Indeed in recent months United Airlines has become the second major US airline to announce it will no longer carry bulk
shipments of lithium-ion batteries. Delta Airlines stopped bulk shipments of the batteries in February of 2015. This was due to aviation officials believing that lithium-ion batteries contributed to fires that destroyed two Boeing 747 cargo planes, killing all four crew members.

Tests by the Federal Aviation Administration found overheating batteries could cause major fires. In its tests, the FAA filled a cargo container with 5,000 lithium-ion batteries and a cartridge heater, which was added to simulate a single battery overheating. The heat from the cartridge triggered a chain reaction in other batteries, with temperatures reaching about 600°C. This was followed by an explosion, which blew open the container door and set the cargo box on fire.

These fears are starting to filter through to the general population and anyone who has felt a cellphone or a laptop get very hot needs little persuading that where there is heat, there is fire. Therefore I shall be reviewing a new technology in Lithium batteries which promises to bring safety benefits amongst its other attractions.

A Less Explosive Option

Lithium titanate (lithium titanium oxide or LTO) batteries have appeared on the scene in recent times but have only gained a lot of traction in usages for mass storage devices such as for operating electric buses, with Toshiba being a major developer of the technology.

LTO battery technology are significant incorporates a number of economical as well as ecological aspects important for expanding renewable green energy.
The LTO technology is based on modified lithium-ion batteries and employs additional lithium-titanate nanocrystals on the surface of its anode and instead of the conventional carbon material that is used in normal lithium-ion batteries.

As a result the anode has a surface area of around 100 square meters per gram, which is a quantum more than the three square meters per gram achieved when using conventional carbon material, allowing electrons to enter and leave the anode far more quickly.

As a result of this larger surface area re-charging of the LTO battery is faster. The improvement in the surface area of the battery drastically increases the LTO cells general stability and further improves the LTO batteries safety aspects.

**Uses – Going Lightweight**

While in the past I have written about large scale Vanadium batteries (some the size of shipping containers) the Lithium
titanate batteries fill a niche in between the very large and more micro formats in hand-held devices. They are able to store and deliver current peaks that are between 30 and 100 times that of ordinary lithium batteries.

LTO batteries have applications in electric vehicles and charging stations, tourist coaches, yachts, wind and solar energy storage power, traffic signals, solar hybrid street lighting, UPS power supply, home storage, disaster relief emergency, weather radar, electricity, smart grid, communication base stations, hospitals, finance, telecommunications as well as system critical backup power systems.

LTO technology offers the highest energy to weight ratio seen yet, with particular usage potential in transport modes that require a low weight battery, such as light vehicles, e-cars and fork lifts.

Clearly the tendency here is for locations that are off grid but where the device being powered is not a substantial consumer of energy.

**The Main Advantages**

It is surprising that more airtime has not been given to Lithium Titanate batteries considering that they have several crucial advantages over their more prolific competition, the Lithium Ion battery. The main points on which they do better are:

- Long lifespan
- Rapid charging
- Less risk of auto-combustion
- Operates better in low temperatures than Lithium Ion batteries

From the point of view of the manufacturers of the appliances into which the batteries are installed the main attraction is
the long lifespan with user gripes mostly being about the short lifespan of laptops and particularly cellphones these days with apps installed chewing through the charged power in no time. LTO batteries have a lifecycle of up to 20,000 cycles as compared to only 2000 in standard lithium based batteries.

As for the other advantages:

Rapid Battery Charging – As mentioned the higher surface area per gram allows the electrons to enter and exit the anode faster, thus making it possible to recharge the battery very rapidly. These batteries can be safely charged between six and ten minutes in contrast to the 8 hours required for other rechargeable batteries. Additionally, the recharge efficiency exceeds an entire 98%, much higher than conventional energy storage mechanisms.

Safety advantages – For us this is one of the biggest marketing angles for the future will be enhanced safety. Householders in particular are getting edgy about the stories they hear about Lithium Ion batteries and their combustibility which makes for a whole new niche in “low-risk” alternatives.

The higher level of safety with LTO batteries is due to the lower operating voltage of this technology. The argument goes that as the batteries are entirely free of carbon, they avoid thermal runaway or overheating which is a main cause of fires in traditional energy storage systems.

Low-Temperature Performance – due to the nanotechnology employed, LTO batteries have a much better low-temperature performance in comparison to other battery technologies as a result these batteries are able to obtain up to 80% of its full capacity at -30°C.

It should be noted though that there is a disadvantage to LTO batteries in that they have a lower inherent voltage (2.4 V/cell), which leads to a lower energy density than conventional lithium-ion battery technologies. However, the
energy density of LTO batteries is still higher than lead acid and NiCd batteries.

**Just in Passing**

We might note that Neometals (NMT.ax), with its Mt Marion lithium deposit and its Barrambie Titanium deposit is the only company we know that has both parts of the chemical equation for Lithium Titanate batteries.

**Conclusion**

The first thought that struck us when noting the low to no carbon nature of these batteries was the potential implications for those in the graphite mining community who are hitching their stars to the carbon component of the Lithium Ion battery. We wonder if that might not be akin to investing in future development of the penny-farthing bicycle!

When we raised the subject of this new battery with Jack Lifton he responded that he had indeed heard of the new technology and in fact had been talking recently to a company in his bailiwick of Troy, Michigan, that was changing over to Lithium Titanate electrodes to improve power density. They told him that while it is more expensive and complicated, there is a big improvement in cycle life.

So it is obvious that LTO technology has managed to trump that of Lithium Ion batteries on four key fronts, but as yet has not captured the attention or imagination of the public. It is definitely a technology to be watched because it not only may oust Lithium Ion batteries from some of their applications but it also might provide a significant new demand source for Titanium miners.