Ultra-fast charging batteries that can be 70% recharged in just two minutes

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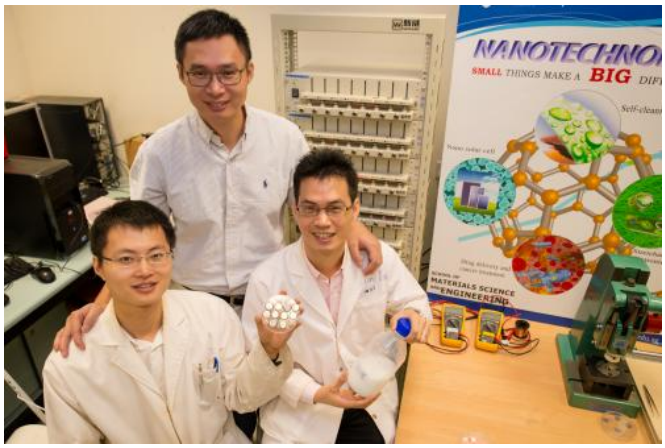


(Clockwise from top) NTU Assoc Prof Chen Xiaodong with research fellow Tang Yuxin and PhD student Deng Jiyang

Scientists from Nanyang Technological University (NTU Singapore) have developed a new battery that can be recharged up to 70 per cent in only 2 minutes. The battery will also have a longer lifespan of over 20 years.

Expected to be the next big thing in battery technology, this breakthrough has a wide-ranging impact on many industries, especially for electric vehicles which are currently inhibited by long recharge times of over 4 hours and the limited lifespan of batteries.

This next generation of lithium-ion batteries will enable electric vehicles to charge 20 times faster than the current technology. With it, electric vehicles will also be able to do away with frequent battery replacements. The new battery will be able to endure more than 10,000 charging cycles – 20 times more than the current 500 cycles of today's batteries.

NTU Singapore's scientists replaced the traditional graphite used for the anode (negative pole) in lithium-ion batteries with a new gel material made from titanium dioxide, an abundant, cheap and safe material found in soil. It is commonly used as a food additive or in sunscreen lotions to absorb harmful ultraviolet rays.

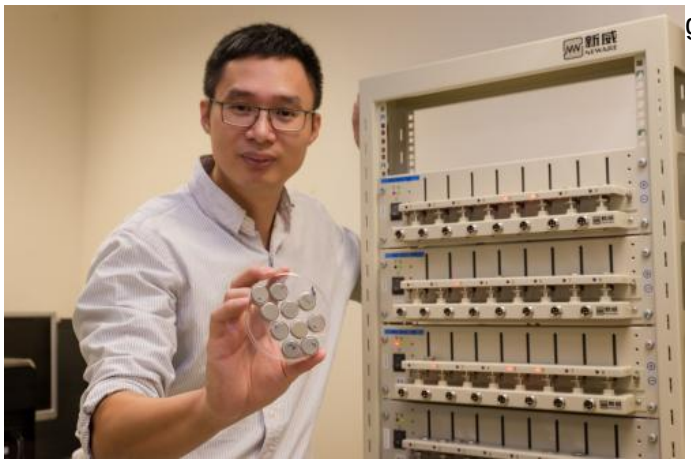
Naturally found in a spherical shape, NTU Singapore developed a simple method to turn titanium dioxide particles into tiny nanotubes that are a thousand times thinner than the diameter of a human hair.

This nanostructure is what helps to speeds up the chemical reactions taking place in the new battery, allowing for superfast charging.

Invented by Associate Professor Chen Xiaodong from the School of Materials Science and Engineering at NTU Singapore, the science behind the formation of the new titanium dioxide gel was published in the latest issue of *Advanced Materials*, a leading international scientific journal in materials science.

NTU professor Rachid Yazami, who was the co-inventor of the lithium-graphite anode 34 years ago that is used in most lithium-ion batteries today, said Prof Chen's invention is the next big leap in battery technology.

"While the cost of lithium-ion batteries has been significantly reduced and its performance improved since Sony commercialised it in 1991, the market is fast expanding towards new applications in electric mobility and energy storage," said Prof Yazami.



NTU Assoc Prof Chen holding the ultrafast rechargable batteries in his right hand, with the battery test station to his left

Last year, Prof Yazami was awarded the prestigious Draper Prize by the National Academy of Engineering for his ground-breaking work in developing the lithium-ion battery with three other scientists.

"There is still room for improvement and one such key area is the power density – how much power can be stored in a certain amount of space – which directly relates to the fast charge ability. Ideally, the charge time for batteries in electric vehicles should be less than 15 minutes, which Prof Chen's nanostructured anode has proven to do."

Prof Yazami, who is Prof Chen's colleague at NTU Singapore, is not part of this research project and is currently developing new types of batteries for electric vehicle applications at the Energy Research Institute at NTU (ERI@N).

Commercialisation of technology

Moving forward, Prof Chen's research team will be applying for a Proof-of-Concept grant to build a large-scale battery prototype. The patented technology has already attracted interest from the industry.

The technology is currently being licensed to a company and Prof Chen expects that the new generation of fast-charging batteries will hit the market in two years' time. It holds a lot of potential in overcoming the longstanding power issues related to electro-mobility.

"With our nanotechnology, electric cars would be able to increase their range dramatically with just five minutes of charging, which is on par with the time needed to pump petrol for current cars," added Prof Chen.

"Equally important, we can now drastically cut down the waste generated by disposed batteries, since our batteries last ten times longer than the current generation of lithium-ion batteries."

The long-life of the new battery also means drivers save on the cost of a battery replacement, which could cost over USD$5,000 each.

Easy to manufacture

According to Frost & Sullivan, a leading growth-consulting firm, the global market of rechargeable lithium-ion batteries is projected to be worth US$23.4 billion in 2016.

Lithium-ion batteries usually use additives to bind the electrodes to the anode, which affects the speed in which electrons and ions can transfer in and out of the batteries.

However, Prof Chen's new cross-linked titanium dioxide nanotube-based electrodes eliminate the need for these additives and can pack more energy into the same amount of space.

"Manufacturing this new nanotube gel is very easy," Prof Chen added. "Titanium dioxide and sodium hydroxide are mixed together and stirred under a certain temperature. Battery manufacturers will find it easy to integrate our new gel into their current production processes."

More information: Tang, Y., Zhang, Y., Deng, J., Wei, J., Tam, H. L., Chandran, B. K., Dong, Z., Chen, Z. and Chen, X. (2014), "Mechanical Force-Driven Growth of Elongated Bending TiO2-based Nanotubular Materials for Ultrafast Rechargeable Lithium Ion Batteries." *Adv. Mater.*, 26: 6111–6118.

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