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Pomegranate-inspired battery design doubles stored energy

A new pomegranate-inspired design is the basis of a longer-lasting lithium-ion battery created by US researchers. They designed a battery with an anode made from 'silicon pomegranates', which doubles the amount of energy that can be stored compared to a standard carbon anode.

Lithium-ion batteries are the rechargeable batteries that many of us use to charge our phones, tablets and laptop computers. Like most batteries, they have two electrodes — a cathode and an anode. The anode is the part that absorbs the lithium ions to store the charge during recharging.

There is significant interest in making more efficient lithium-ion batteries — for commercial as well as sustainability reasons. For example, the European Commission (EC) is currently seeking proposals for research projects focusing on a new generation of batteries that would be cheaper, longer-lasting and quicker to charge.[1] Its main motivation is for batteries to be developed that could be used in electric cars.

The new battery design replaces the graphite (solid carbon) anodes of ordinary lithium-ion batteries with anodes made from silicon and carbon nanomaterials. They should theoretically last longer because they can store more energy. Silicon nanoparticles form the 'seeds' of the pomegranates, which are encased in a thin carbon framework. Each silicon seed is housed in its own carbon bubble, with room to rattle around. Practically, the pomegranates exist in powder form, with the pomegranate structure only visible under a microscope.

This structure solves two main problems with silicon anodes. First, silicon anodes expand during charging so that after repeated charging cycles they disintegrate. The seed casings in the new design provide room for growth. Secondly, the outer casing keeps the silicon away from the electrolyte in the battery. Without this casing, the silicon would react with the electrolyte to form a substance that would clog up the battery.

In tests, the new silicon-based anode was capable of storing more than twice as much energy as an ordinary graphite anode. It was also very stable. After charging the pomegranate-inspired battery 1 000 times, the researchers found that it maintained 97% of its charge capacity. They also noted that no complex equipment or chemical processing was required to make their pomegranates.

In a previous study, the researchers showed that the silicon for their battery anodes could be extracted from rice husks,[2] a recycled resource. Rice husks are some of the most high-volume waste products from farming and other research teams have also used them to make battery anodes.[3] One ton of rice husks is produced for every five tons of rice, amounting to more than 100 million tons every year.

Such sustainable sources address the EC's call for production processes that consider 'the availability of raw materials'. Today, silicon is made from silicon dioxide (silica) in energy-intensive processes that need high temperatures.[4] The silica in rice husks would also have to be converted into silicon, and it is not yet known whether these production process would be commercially viable.

Environment

1. http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2528-nmp-17-2014.html
2. http://www.nature.com/srep/2013/130529/srep01919/full/srep01919.html#affil-auth
3. http://www.pnas.org/content/early/2013/07/03/1305025110
4. http://www.nature.com/nature/journal/v446/n7132/abs/nature05570.html