Ultrafast charging of batteries using fully new anode material

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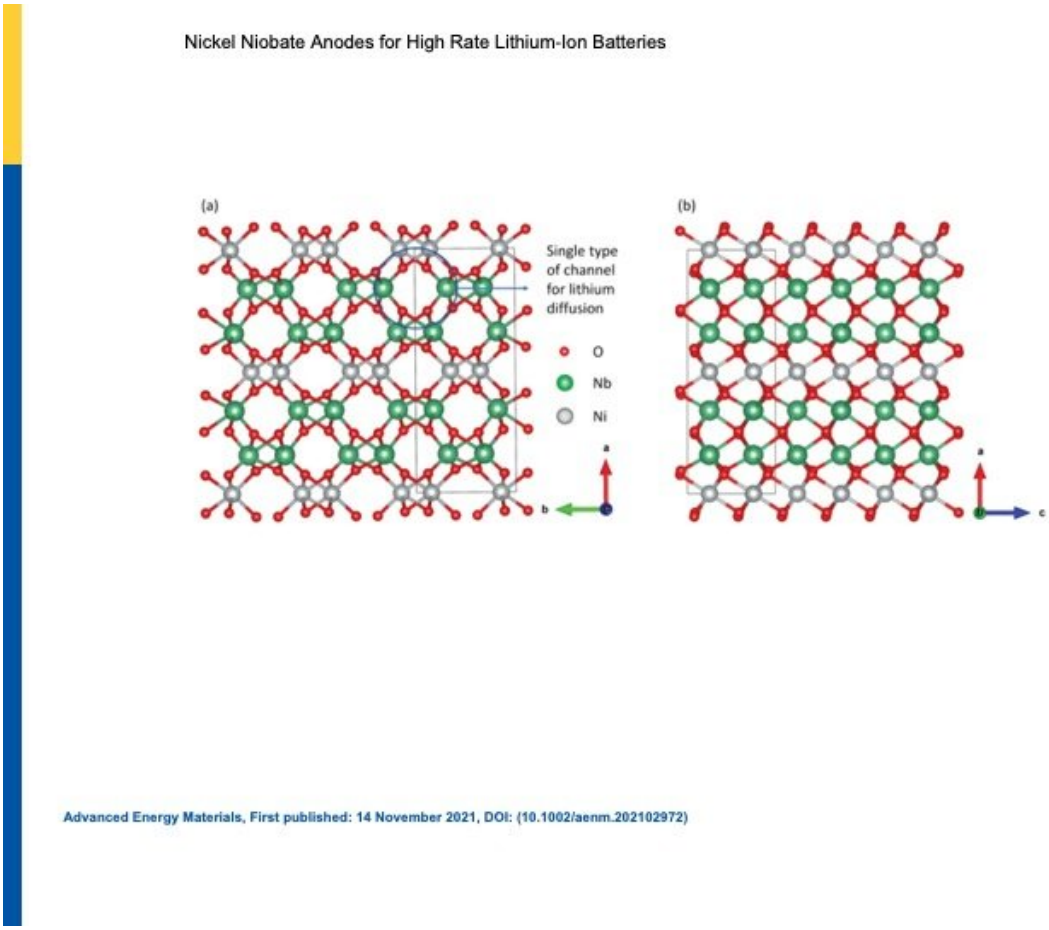

Nickel niobate has a regular and open crystal structure, with many channels for charge transport. Credit: University of Twente

By using a fully new material, nickel niobate, for the anode of lithium-ion batteries, the charging speed can be improved by ten times, according to researchers of the University of Twente. This is possible without the risk of damaging the anode material, causing battery breakdown or reducing its lifetime. An additional advantage is that the manufacturing process is not complicated. The researcher published their first results using batteries with the new anode in the *Advanced Energy Materials* journal.

Battery performance can still significantly be improved, whether it is for electric vehicles or for the electricity grid. Faster charging and decharging, or a higher energy density resulting in more compact and lighter batteries: often there is some kind of 'trade-off' of these two. The high-speed chargers by the motorway are an example. Not all cars and car batteries are prepared for this. Consequently, there is a worldwide search for new materials. An important aspect, next to the technical specifications, is drastically improving the sustainability and carbon footprint of battery production.

The new material nickel niobate ($NiNb_2O_6$) appears to have very attractive properties and even after many cycles of ultrafast charging, it returns to its original level. This primarily has to do with its attractive 'open' and regular crystal structure, resulting in channels for charge transport that are identical.

This means that it performs better than the standard anode material graphite. That is an 'open' material too, and it is simple. But after some cycles of high-speed charging, it will not return to the original level, or it will even break down. In the search for alternatives, at the University of Twente as well, new types of nano-structured materials are an option: a disadvantage, however, may be that the channels are organized in a more random way. This may even cause deposit of lithium on the anode material, resulting in poorer performance after every cycle. Apart from

that, manufacturing these materials is complicated. For nickel niobate, a cleanroom infrastructure is not necessary.

The high charging and decharging rates do have consequences for the weight and energy density, however. Nickel niobate is more compact than graphite, so it has a higher volumetric energy density.

The researchers tested the first full batteries with the new anode material, for various existing cathode materials as well. They conclude that this version would be ideal for introducing it into an energy grid, in electrically powered machines in that require fast charging and decharging, or in electrically powered heavy transport. For using it in electrically powered cars, still some steps have to be taken. The new anode is also suitable for replacing lithium by, for example, natrium, research leader Professor Mark Huijben says.

More information: Rui Xia et al, Nickel Niobate Anodes for High Rate Lithium-Ion Batteries, *Advanced Energy Materials* (2021). DOI: 10.1002/aenm.202102972

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