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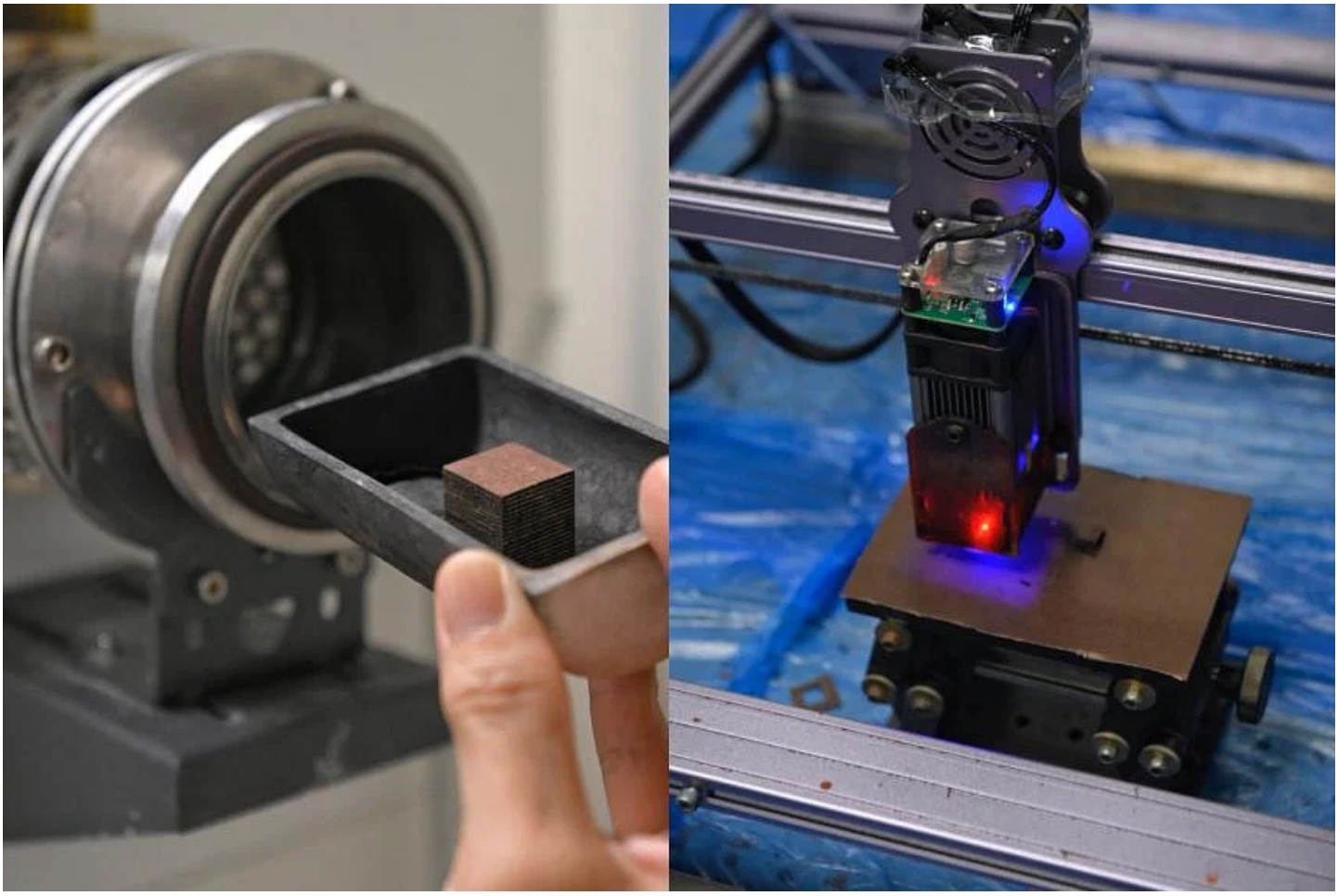
Waste paper could be given new life in batteries for phones, electric vehicles



NTU's tests showed that 1g of paper anodes – roughly the size of a fingernail – is enough to store power in a 100mAh battery. ST PHOTO: MARK CHEONG

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SINGAPORE - Discarded newspapers and cardboard boxes have found new life as battery parts, gas filters and fire protection insulators after scientists found a way to combust and compact waste paper into small blocks of carbon.

In developing one of the world's first uses of waste paper in battery production, Nanyang Technological University (NTU) scientists may also address the biggest bugbear of the electric vehicle (EV) industry – a heavy battery unit at the vehicle's core.

Discarded paper products, such as paper packaging, kraft paper bags and cardboard, form nearly a fifth of waste generated in Singapore in 2020, said NTU Assistant Professor Lai Chang Quan, who helmed the project.

"Paper can be recycled only four to six times before it is useless because the quality drops each time," he said in a presentation on the project on Nov 23. "And when it cannot be used, the paper is incinerated, releasing greenhouse gases."

Prof Lai, who teaches in NTU's School of Mechanical and Aerospace Engineering, added: "Here, we are taking something cheap and making it more valuable by upcycling waste paper into carbon foams without releasing greenhouse gases."

The carbon blocks are made by heating stacks of waste paper in a furnace at up to 1,200 deg C in the absence of oxygen, so that it is not incinerated but, instead, reduced to pure carbon.

The paper blocks can be used as carbon anodes – an essential part of batteries that stores electricity.

Carbon anodes are often made of graphite forged from fossil fuels.

But replacing graphite with paper can reduce the pollution caused by batteries, as well as cut down on overall cost as recycled material is used instead, said Prof Lai.

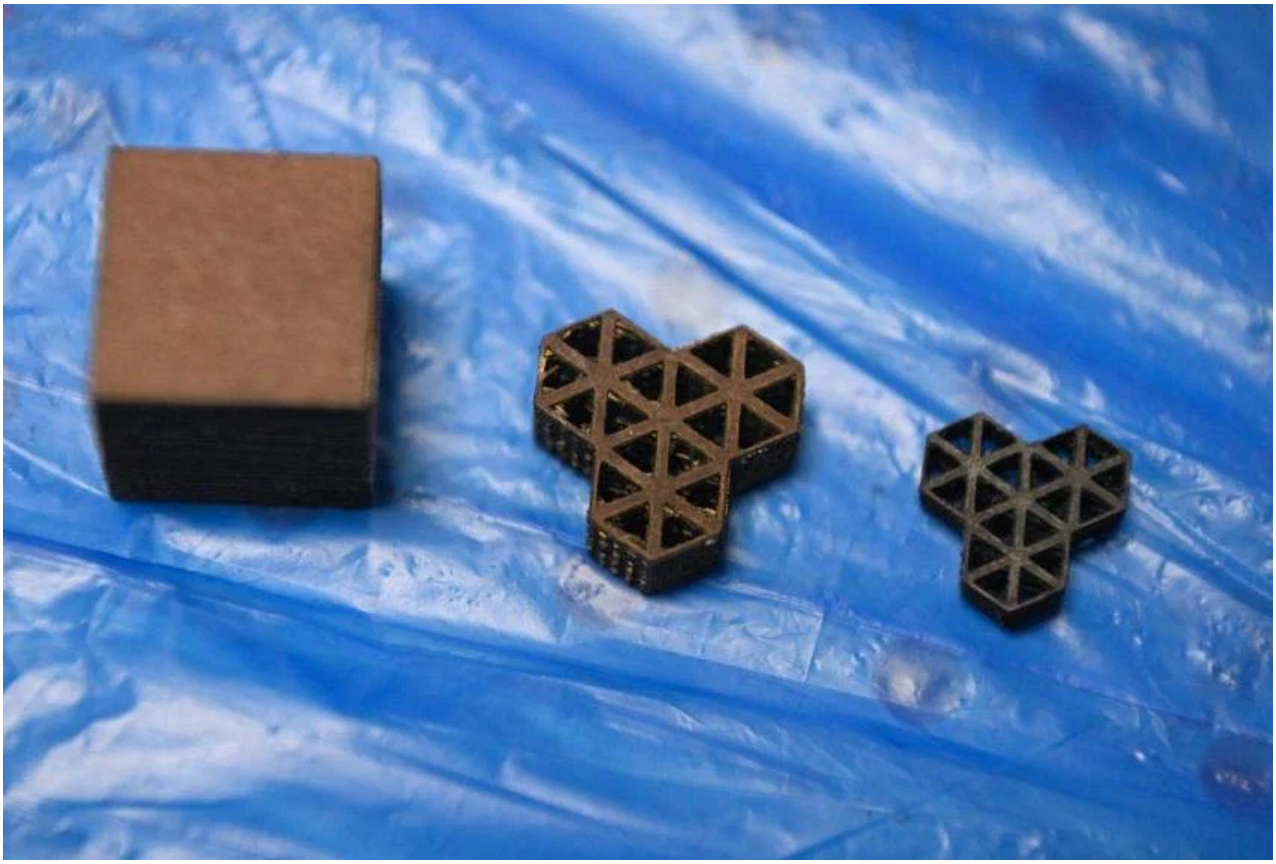
NTU's tests showed that 1g of paper anodes – roughly the size of a fingernail – is enough to store power in a 100 milliampere hour battery. A typical smartphone would need around 40g of the anodes, said Prof Lai. This is roughly the same weight as graphite found in today's phones.

The paper anodes can be recharged up to 1,200 times – twice as much as typical anodes found in current phone batteries, said NTU.

The team has since filed for a patent with NTU's innovation and enterprise arm, NTUitive, and is working towards commercialising their work in the next five years.

The automotive industry may benefit from the invention as it ramps up the use of batteries with the increasing number of EVs.

Prof Lai said future manufacturers can use paper anodes to line an EV's frame to build the battery as part of the car's chassis.



This will lighten the vehicle's weight as it removes the need for heavy battery packs that are typically housed at the base of the EV, he added.

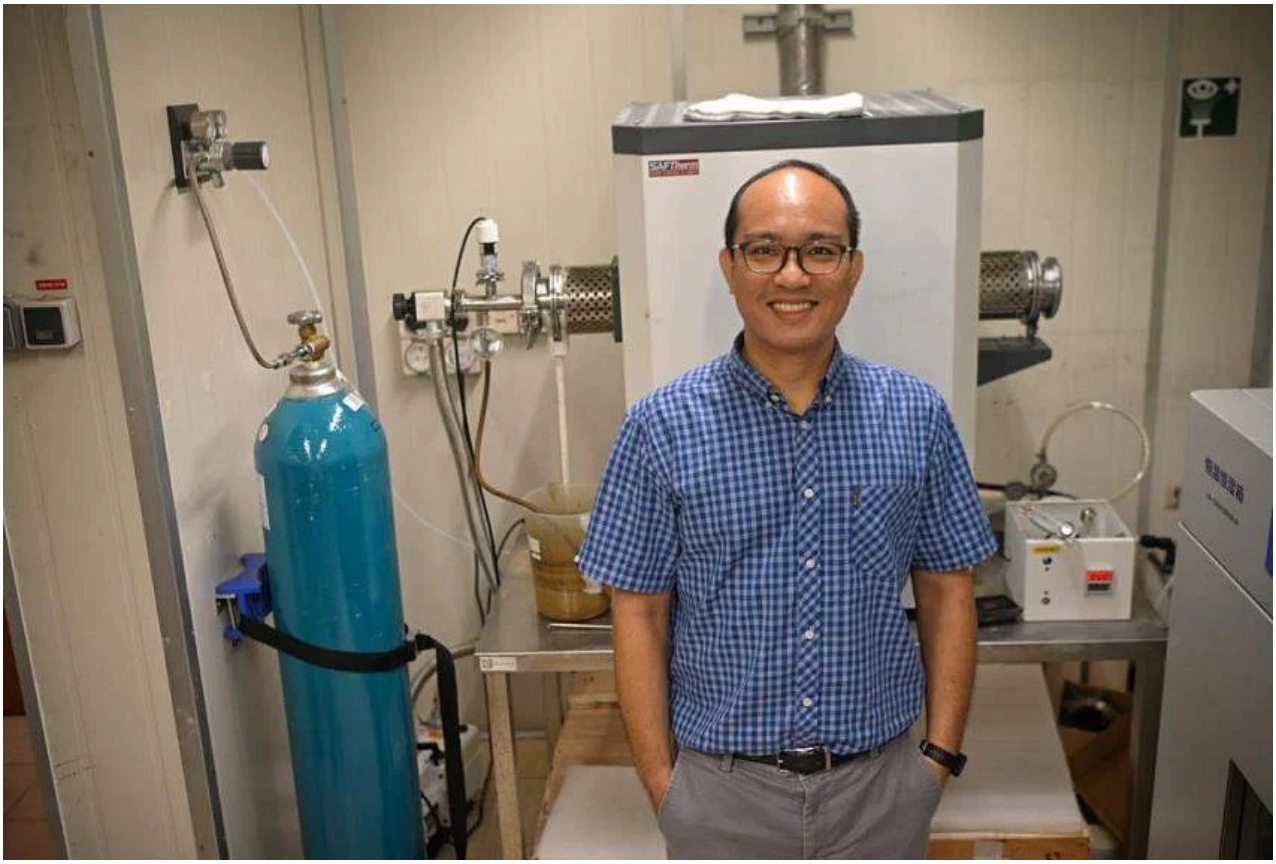
Standard carbon anodes cannot be moulded into a frame as they are too fragile. But paper anodes can withstand four times the amount of physical stress as they retain the fibrous molecular structure of paper, which is naturally strong, said Prof Lai.

NTU's carbon blocks also offer a sustainable way to develop carbon foam, which is often used for noise isolation in sound studios and fireproof protection, he added.

The research team will conduct further research to improve the material's energy storage capacity and cut the heat energy needed to convert the paper into carbon.

Oils are also extracted from the paper in the furnace and can be used as biofuel, offsetting the energy consumed in heating up the paper, said Prof Lai, when asked about the energy-intensiveness of the carbonisation process.

He added: "We hope that our anodes will serve the world's quickly growing need for a sustainable and greener material for batteries, whose manufacturing and improper waste management have been shown to have a negative impact on our environment."



Commenting on the NTU project, Professor Juan Hinestroza from Cornell University's Department of Human Centred Design said: "Any discovery that allows the use of waste as a raw material for high-value products like electrodes and foams is indeed a great contribution."

Prof Hinestroza, who was not involved in NTU's research, said: "I think that this work may open a new avenue and motivate other researchers to find pathways for the transformation of other cellulose-based substrates, such as textiles and packaging materials, which are being discarded in large quantities all over the globe."