

Tech

Waste paper could see new life as battery parts for phones

NTU scientists' method of turning such material into carbon could also power EVs

Osmond Chia

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 fire-proof 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.

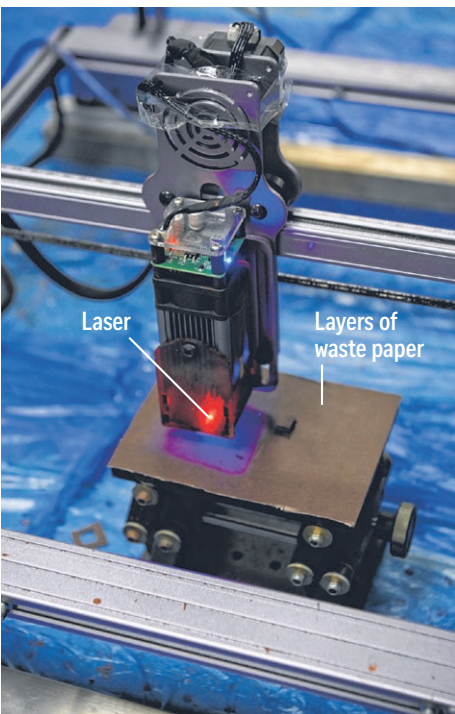
Oils are also extracted from the paper in the furnace and can be used as biofuel, offsetting the energy consumed in heating up the pa-

Adding value through upcycling

Nanyang Technological University (NTU) has come up with a new way to extract carbon for batteries and foam blocks, relying on waste paper instead of fossil fuels. **The Straits Times** takes a look at how carbonised paper is made and its potential uses.

MAKING CARBON FROM WASTE PAPER

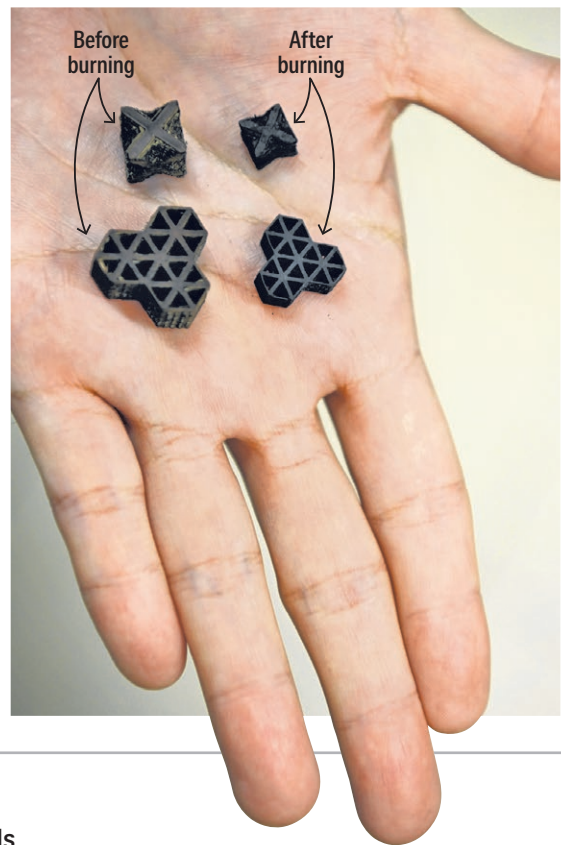
1 Waste paper is stacked and cut with a laser to form bricks that can be used to build carbon foam blocks or battery anodes.



2 The blocks are placed in a furnace for about 24 hours at up to 1,200 deg C. Oxygen is sucked out of the furnace to ensure the paper produces carbon.



3 The result: blocks of carbon made out of burnt paper. NTU scientists say these blocks are stronger, more flexible and better at storing electricity than carbon made of fossil fuels.

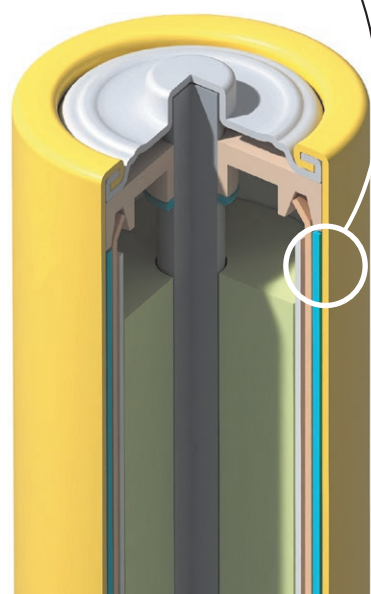
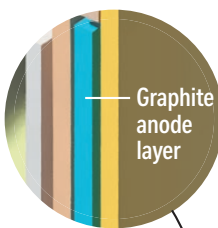


HOW PAPER CARBONISATION CAN BE USED

Carbonised paper offers a new way to extract carbon, which is typically forged from fossil fuels

Cleaner battery cells

Carbonised paper replaces the graphite anode layer in a battery cell and releases electrons to generate electricity when a device is used.



Carbon foam blocks

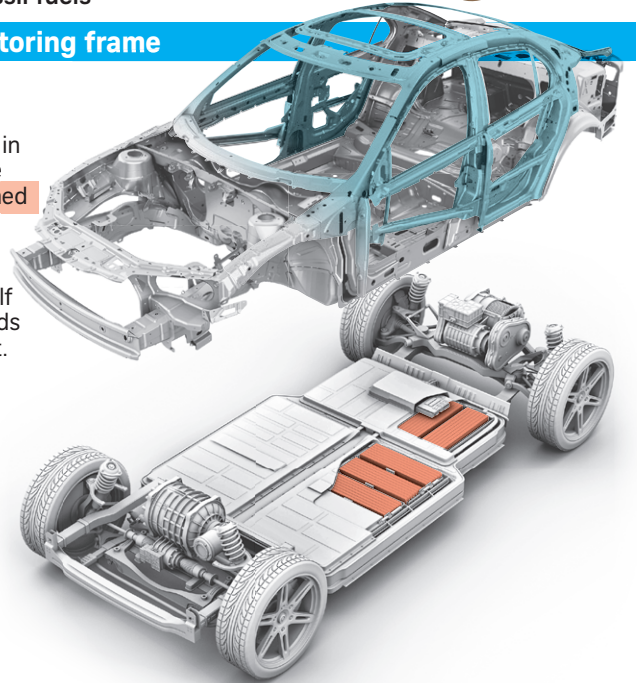
Instead of fossil fuels, carbonised paper offers a cleaner alternative resource for building carbon foam blocks, which are often used for fire protection walls, crash absorption panels and sound absorption panels in studios.



Electricity-storing frame

NOW
Anodes that store electricity in battery cells are typically contained in a hub at the base of electric vehicles (EVs). But the hub itself is heavy and adds to a car's weight.

FUTURE
Manufacturers can line an EV's frame with carbonised paper anodes, building the battery as part of the frame, reducing the vehicle's weight.



HOW MUCH CARBONISED PAPER IS NEEDED IN EVERYDAY ELECTRONICS

	Battery capacity	Weight of carbonised paper required
Portable speaker	3,600mAh*	36g
Smartphone	4,000mAh	40g
Electric vehicle	50kWh	100kg–200kg

NOTE: *mAh = milliampere hour

Source: NTU TEXT: OSMOND CHIA PHOTOS: MARK CHEONG, FOSTERING ARTS AND DESIGN, ISTOCK STRAITS TIMES GRAPHICS

per, 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 improv-

er 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 re-

searchers 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."

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