THE BEAUTY OF BENDABLE BATTERIES

Какво може да осигури чиста околна среда по-успешно от електронната кола? Alok Jha разговаря с Donald Sadoway, американски учен, специалист в разработването на ултралека батерия с голям капацитет. difficult

The **Guardian**

Just over ten years ago, Donald Sadoway went for a drive in his first electric car. It was an early, clunky design, but the experience changed his world. Since then, he has put all his time and energy towards making electric cars a commercial reality.

"For personal transportation, it's lunacy that we don't have electric vehicles," says Sadoway, a professor of materials science at the Massachusetts Institute of Technology (MIT). "It's crazy to be burning carbon to move around short distances." Sadoway says that, for cities in which traffic congestion is a problem, the future is now. "The only thing that's missing is a viable battery."

Our increasingly mobile world depends on the ability to store and move energy around with us in the form of batteries. But lack of academic and commercial interest in the field, and the concentration of what effort there is on developing fuel cells and hydrogen cars, means innovation has hit a wall.

This is why Sadoway is getting excited about crisp packets. Smoothing one out in front of him, he describes how this thin sandwich of metal and plastic may now be the idea that will break through that technological wall. His remarkable idea is a new type of battery that is as thin as a crisp packet and as cheap as the crisps inside.

The Slimcell, as Sadoway calls his invention, is a sandwich of lithium and a special type of Perspex. Because it is so light, it solves the weight ▸

carbon ['kɑːbən]	въглерод
clunky [klʌŋki]	*разг.* тромав
crisp packet ['krɪsp ˌpækɪt]	пакет от чипс
fuel cell ['fjuːəl sel]	горивна клетка
hydrogen car ['haɪdrədʒən ˌkɑː]	кола на водород
lunacy ['luːnəsi]	лудост
materials science [mə'tɪərɪəlz ˌsaɪəns]	материалознание
traffic congestion ['træfɪk kənˌdʒestʃən]	задръстване на движението
vehicle ['viːɪkəl]	превозно средство
viable ['vaɪəbəl]	надежден

"It's crazy to be burning carbon to move around such short distances"

Donald Sadoway: a firm believer in flexible energy

Cleaner traffic? Electric-powered cars would help

problem that has prevented the widespread use of batteries in electric cars. The Slimcell can store a huge amount of energy per kilogram.

Batteries work because chemical reactions inside them force electrons to collect at one of the two electrodes. If you connect any appliance, the electrons travel through it to the other electrode, making an electrical circuit.

A traditional lead acid battery — in which one electrode is made of lead, the other of lead dioxide, and sulphuric acid floats between the two — has a capacity of 35 watt hours per kilogram (Wh/kg). The nickel metal hydride (NiMH) batteries that became available in the early 1990s and made laptop computing possible, have a capacity of about 90 Wh/kg. Newer lithium ion batteries, used in mobile phones and today's laptops, provide 125 Wh/kg.

"At 125 Wh/kg, you can drive a car 125 miles (200 kilometres) on a single charge — that's not good enough," says Sadoway. "You need to go about 250 miles on a single charge before it'll become widely accepted. So you need a battery that's about 250 Wh/kg. We've got batteries in my lab right now that are 300 Wh/kg, and I can see the possibility of breaking 400 Wh/kg."

The Slimcell achieves such high energy densities by getting rid of weight. However, Sadoway was able to take only a little weight off the electrodes in a lithium ion battery, because the metal is so light. Instead, he focused on an element that was essential but that didn't contribute to the storage capacity: the liquid electrolyte. "An ideal battery is maximally electrode and minimally everything else," says Sadoway. "The electrolyte doesn't contribute to storage capacity, but you have to have it. What you would like is the thinnest electrolyte."

Teaming up with his MIT colleague Anne Mayes, Sadoway began working on ways to remove the liquid. "The only way we were going to break the 200 Wh/kg, I reasoned, was to ask if it were possible to invent a solid polymer electrolyte that had the mechanical properties of a solid, and the electrical properties of a liquid," he says. After many unsuccessful attempts, Sadoway's team found the wonder material he needed.

The Slimcell's sandwich of metal electrodes and plastic electrolyte is not only light and easy to make, it also makes batteries much safer. Because there is no liquid, the battery can't leak. If it is somehow punctured in one part, the rest of the battery continues to work.

"There are various companies that claim to have variants of a solid separator, but, as far as I know, these companies are all infusing some kind of polymer host with something that's an organic liquid," says Sadoway.

Sadoway and Mayes's team have continued to improve their polymer electrolyte. By developing a way to evaporate the liquid on to the lithium electrodes, they have made the battery as thin and light as physically possible. The next step would be industrial production, but Sadoway estimates that the Slimcell is at least five years from being commercially available.

Although the battery is remarkable, the MIT team behind it sees problems in finding a market. "What is re-

appliance [ə'plaɪəns]	уред
application [ˌæplɪ'keɪʃən]	употреба
break (a limit) [ˌbreɪk]	преминавам (граница)
charge [tʃɑːdʒ]	зареждане
electrical circuit [ɪˌlektrɪkəl 'sɜːkɪt]	ел. верига
electrolyte [ɪ'lektrəʊlaɪt]	електролит
energy density ['enədʒi ˌdensəti]	енергийна плътност
evaporate sth. [ɪ'væpəreɪt]	изпарявам
fender ['fendə] *US*	калник
host [həʊst]	матрица
infuse sth. with sth. [ɪn'fjuːz wɪð]	обработвам с
lab(oratory) [læb]	лаборатория
lead [led]	олово
lead acid battery [ˌled 'æsɪd ˌbætri]	оловна батерия
lead dioxide [ˌled daɪ'ɒksaɪd]	оловен диоксид
leak [liːk]	протичам
lithium ion battery [ˌlɪθiəm 'aɪən ˌbætri]	литиевойонна батерия
market pull [ˌmɑːkɪt 'pʊl]	търсене на пазара
medical device ['medɪkəl dɪˌvaɪs]	медицински уред
monitor sth. ['mɒnɪtə]	наблюдавам
nickel metal hydride (NiMH) [ˌnɪkəl ˌmetəl 'haɪdraɪd]	никел-метал-хидрид
puncture sth. ['pʌŋktʃə]	пробивам
reason ['riːzən]	разсъждавам
recoup (an investment) [rɪ'kuːp]	възстановявам (инвестиция)
separator ['sepəreɪtə]	сепаратор, вложка
solid ['sɒlɪd]	твърд
stable ['steɪbəl]	стабилен; *тук:* устойчив
storage capacity ['stɔːrɪdʒ kəˌpæsəti]	капацитет
strap [stræp]	каишка
sulphuric acid [sʌlˌfjʊərɪk 'æsɪd]	сярна киселина
technology push [tek'nɒlədʒi pʊʃ]	технологичен напредък
variant ['veəriənt]	вариант
versatility [ˌvɜːsə'tɪləti]	гъвкавост
wary: be ~ of sth. ['weəri]	не смея да

Hooked on power: mobility depends on light batteries

"People would like better batteries but they are worried about making the investment"

quired is both a technology push and a market pull," says Sadoway. He believes that, as in the past, the main problem is likely to be resistance from the firms that produce batteries. In the mid-1990s, just as a lot of companies had invested heavily in NiMH batteries, the more advanced lithium ion batteries came out of nowhere. Instead of welcoming lithium ion, many firms tried to slow its introduction. According to Sadoway, their aim was to sell as many NiMH batteries as possible in order to recoup the money that had been invested in their factories.

"People would like better batteries but they are wary of making investments," Sadoway says. He believes that whoever develops the Slimcell commercially will need to find applications for which specialized batteries don't yet exist — medical devices, for example. "Imagine that the battery in a watch is in the strap, and that there's a medical sensor in there connected to the Internet," he says. This information could be used to determine if patients are taking their medicine regularly. "If someone is monitoring that, they could phone up if the user has forgotten to take some medicine. This could save hundreds of dollars in medical costs later. What's missing? It's a stable battery."

The Slimcell's big advantage is its versatility. "You can do something with this you can't do with any other battery — fold it up, make it conform to the shape," says Sadoway. "You can put the battery behind the screen of a computer, or in the fender of a car, so you can have distributed power. You don't have it in one big block." When such applications become reality, Sadoway's dream of powering electric cars will be a step closer. Which is quite impressive for something that is, basically, just like a crisp packet. BS

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