

[News](#) [Ukraine](#) [Sport](#) [Business](#) [Opinion](#) [Money](#) [Life](#) [Style](#) [Travel](#) [Cult](#)[See all Life](#)

The batteries are mounted low for optimum weight distribution - but have manufacturers paid sufficient attention to their longevity?

Everything you need to know about lithium-ion batteries – but which car makers forgot to tell you

By Andrew English, MOTORING CORRESPONDENT

23 June 2022 • 1:38pm

It's become part of everyday life. "Most of us plug in our laptops or phones to recharge at night without really thinking about it," says Serena Corr, Chair in Functional Materials and Professor in Chemical and Biological Engineering at the University of Sheffield, "but what's happening during charge and discharge is a highly complex process and still not completely understood."

We're talking about lithium-ion (abbreviated to Li-ion) batteries and when someone with a job title like Corr's tells you something is "highly complex", you'd better believe it. These are the batteries that power just about everything these days; as well your mobile phone, computer and power tools, they also drive pretty much all battery-electric cars.

Here we're going to the very heart of that technology. Battery longevity and how the cells degrade determines the useful life of your electric car and how much someone will be prepared to pay for it second-hand, which in turn determines the cost of ownership and monthly costs on a personal contract purchase plan (PCP).

And at the moment, the values of used battery cars are disturbingly low since the used market doesn't understand the technology and is concerned with what happens when battery warranties expire. It's a subject that scares car makers witless.

From an unscripted and wide-ranging breakfast conversation with Jaguar Land Rover's Dr Wolfgang Ziebart at [this year's launch of the Jaguar i-Pace](#) came an acknowledgement of this issue and the suggestion that it might help if all used battery cars came with an independent report on battery health, as well as a need to educate the public about how batteries can be "serviced", with individual cells replaced.



Dr Serena Corr, Chair in Functional Materials and Professor in Chemical and Biological Engineering at the University of Sheffield

Yet when we asked Jaguar officially if it would supply one of its experts to be interviewed for this article we received the following reply: “Batteries are there to be driven and live with while you go about your life. Any benefits around changing, how you charge and drive are very marginal and would completely take away from the driving experience and living with a battery-electric vehicle (BEV), especially the i-Pace.”

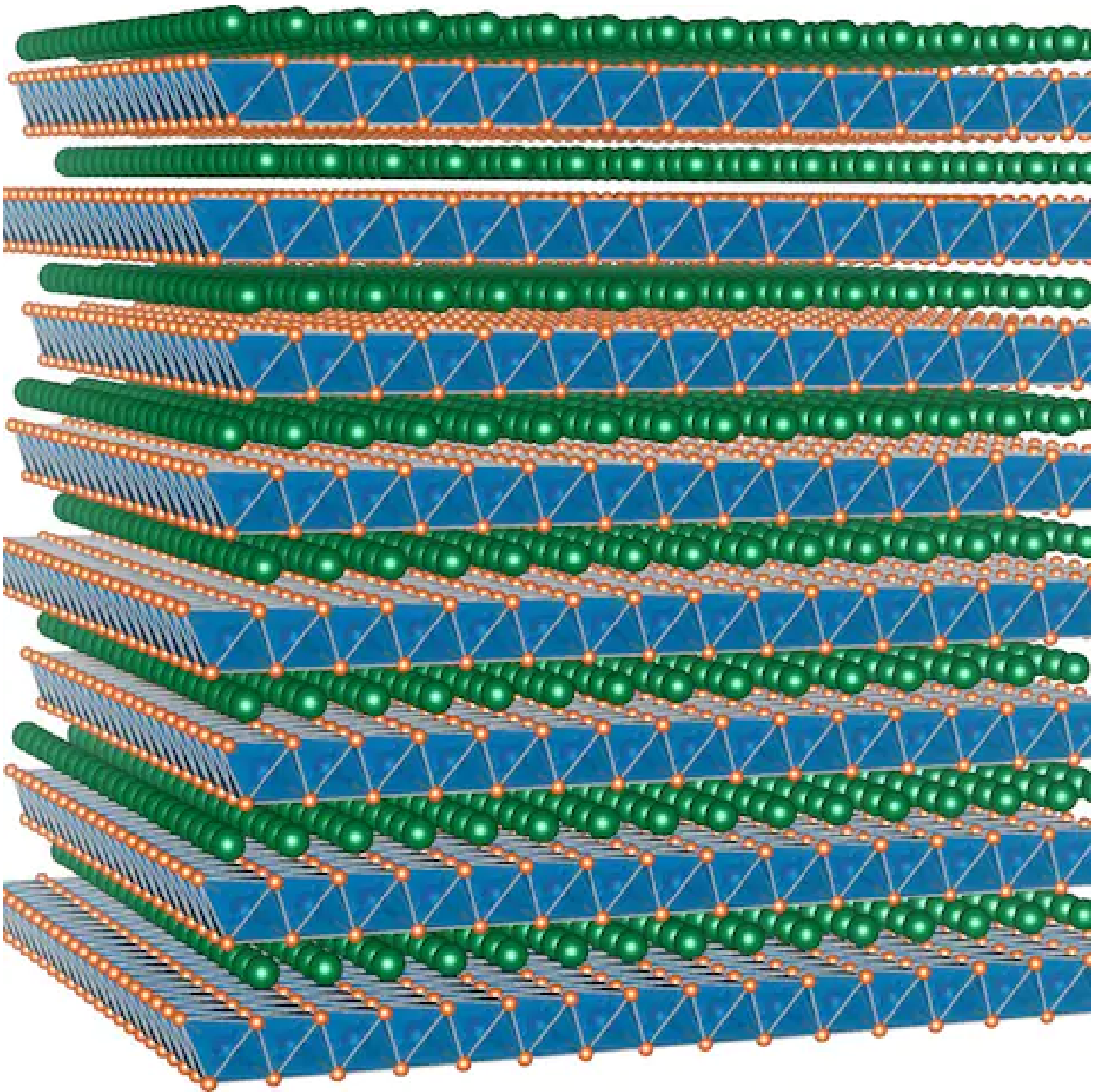
Hum. So the warranty on the iPace’s 90kWh, lithium-ion battery (which comprises 32 LG Chem pouch cells) is eight years or 100,000 miles, which is

redeemable if there's a malfunction or if the battery drops below a 70 per cent state of health. After that you're on your own to "go about your life" with your failing battery; a point that Jaguar appears to be dealing with by not thinking about it too much.

How a lithium-ion battery works

In essence, lithium-ion batteries comprise five main components: cathode; anode; separator; current collectors; and electrolyte. The anode and cathode store the lithium and the electrolyte is the medium through which the positively-charged lithium ions travel.

So when you are charging the battery, the positive electrode (or cathode) gives up some of its lithium ions, which travel through the electrolyte and the separator to the negative electrode (or anode).



The structure of layered NMC cathode material. Lithium ions (in green) slot in and out of the metal oxide layers when you discharge and charge your battery

When you discharge the battery, these lithium ions move from the anode to the cathode generating a flow of electrons through the device (here, an electric motor) you are powering with the battery.

In a lithium-ion battery this process is reversible over many cycles and years, and furthermore Li-ion batteries carry more charge for less weight than

alternatives such as lead-acid or nickel-metal-hydride cells, hence their use to drive cars.

Does charging and usage damage the battery over time?

But as Corr explains, the charging/discharging process isn't without consequence to the health and longevity of the battery.

“The materials that make up your electrodes are typically layered structures, for example the cathode material can be lithium nickel manganese cobalt oxide (or NMC for short),” she says. “One can think of this cathode like sheets of stacked paper, in between which the lithium ions can slot. As this material undergoes multiple charge and discharge cycles, there are mechanical and chemical processes that can ‘weather’ the cathode and lead to its degradation. These can take the form of rearrangement of atoms, volume changes and even particle cracking.”



A full charge is reassuring, but is it the best thing for the battery? | CREDIT: Andrew Butterson/Alamy

There is also a process of “coating”, where reactions of the electrolyte can lead to a permanent covering on parts of the electrode, which can reduce its capacity to accommodate ions and therefore its ability to hold a charge. This is also affected by how you treat the battery.

“There are a number of issues that can affect degradation, for example responses to external stimuli,” says Corr, “such as temperature, charging and pressure.”

Keeping up? That’s just the beginning, as Corr explains: “Each set of battery chemistry brings its own set of challenges.”

What is the industry doing to reduce battery degradation?

Corr’s work is part of a UK-wide collaboration funded through the Faraday Institution, trying to understand the degradation in EV batteries and avoiding pathways and practises that cause it.

“Car batteries are moving to cathodes with high nickel content, reducing the cobalt content,” she says, “partly because of the cost of cobalt, which has risen steeply in the last few years, and also the ethical concerns of extracting cobalt.”



The Democratic Republic of Congo is the leading cobalt producer, providing 67% of the increasing global demand. This conveyor in Lubumbashi contains raw cobalt for export, mainly to China | CREDIT: SAMIR TOUNSI/AFP/Getty Images

To prolong the lifetime of these batteries, car battery manufacturers employ additives to the electrolyte or coatings on the electrodes to try to protect them against degradation.

“Part of the work we are doing is to develop coatings that can prevent degradation and look at the effect of nanostructuring on degradation mechanisms,” says Corr. “Our team of researchers around the UK has the expertise to assess these degradation mechanisms from the atomic to the battery pack level and provide powerful insights into how degradation might be avoided.”

So is an electric car’s battery like the one in your smartphone?

While all this might be of fantastic interest for the wealthy “early adopters” of battery-electric technology, for most of the populace their up-close-and-personal experience of Li-ion batteries is with their phone battery, which is significantly degraded even after the first year’s use – perhaps understandably, there’s a degree of scepticism out there when you scale up the problem in relation to cars...

Jochen Hermann, head of eDrive development at Daimler, agrees, but points out the difference between a phone battery and the one in a battery-electric car. “With laptops or cellphones, people are squeezing everything, all the energy in this very little spot. It’s not heat-controlled, the charging is depending on what and when you plug it in, sometimes the current changes and it’s all done at the edge - that’s why you see a rapid dropping of the battery capacity in a laptop or smartphone today.”



What happens if your electric car's battery goes the way of your smartphone after a few years? | CREDIT: Chris Rout/Alamy

He says the battery management on an automotive application is comprehensive and based on the key determinants of temperature, pressure and charging rates: “The battery management system, that's key,” he says. “On the software side, but also on the hardware side. How you control the temperature, how many kilowatt hours do you install and how much of that you use and the way you use it. There's also the energy and specifications for the cell, which is difficult and also more expensive.”

Considering that the industry is currently installing lithium-ion cells at a rate of \$140 per kW, the price of cell management on top of that is coming in mightily expensive. As BMW's director of research and development, Klaus Fröhlich, recently told us: “I can look at every individual cell and how it is ageing.”

He reckons that by 2025 battery capacity will have increased by five times, with battery-electric cars capable of travelling about 430 miles between charges. But how long for - and how much will it cost?

How to extend the life of your electric-car battery

Perhaps we are going to have to learn how to look after our cells. Corr says: “Things you can consider to increase battery life? For a start, charging to 100 per cent; it might give you a nice feeling [to have a full charge], but it’s not necessarily a good thing for your battery.”

She explains that 100 per cent charging stresses the cathode: “It’s asking a lot, putting pressure on the battery. They don’t like extremes much.”



Top tips: don't charge the battery fully - and don't let it discharge to zero | CREDIT: Miles Willis/Getty Images Europe

She recommends charging from 50 to 80 per cent only, even in cars which often have software limiting the proportion of the battery capacity it can use in the interests of longevity.

“If you can do your daily commute with less than 100 per cent of charge, then I would avoid fully charging the battery and stay within a lower boundary, say 50 to 80 per cent charge, to try to extend your battery lifetime.

“I would also try to avoid discharging all the way to zero per cent as again this can cause increased degradation to your battery. I can understand the desire to fill up completely, but as we move to a more electrified world we might have to do smarter charging, maybe to limit battery charge to 80 per cent and then the charging automatically stops.”

The road ahead

She also suggests that perhaps we need to choose electric vehicles according to our needs so we don't need to charge them to the max every night. This raises

the interesting idea of buying redundant capacity in the interests of longevity.

“So you’d need a different amount of battery capacity if you regularly did, say, an Aberdeen to Glasgow run rather than for a round-city vehicle,” says Corr. “Extra capacity is no bad thing.”

As we tap into the adoption of renewable electricity generation for a new generation of battery-electric cars we’re becoming more used to the idea of efficiency being subordinate to environmental benefit, but there are still a number of issues we need to grapple with.



Electric cars are the future but we still have to make choices about their environmental impact | CREDIT: Sean Gallup/Getty Images Europe

Lithium-ion batteries are not an environmental or ethical free lunch, either in the electricity that recharges them, the elements that go into their make-up (which are often sourced from some of the most exploitative and dangerous places in the world) or the rare-earth elements that go into the motors they power.

Lithium is dangerous, reactive in air and hard to recycle, so lots of batteries end up in landfill simply as a safety measure.

Battery-electric cars are going to have to be a lot more desirable as a used buy if this technology is going to get fully off the ground and that depends on us understanding how to look after them, car makers being able to service them and having a long-term plan to look after them - not just when new, but also on the day after the warranty runs out.

This article was first published in November 2018