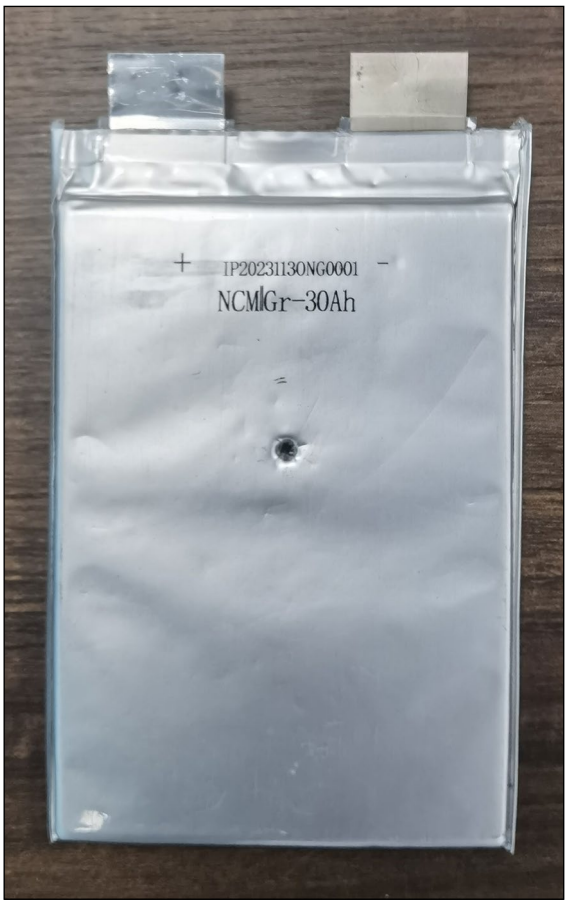
## Li battery passes puncture-resistance test

Puncture a lithium-ion battery: the result is a grave fire hazard. Liquid electrolytes, found in most lithium-ion batteries today, are prone to violently reacting with their surroundings when they leak. A punctured battery is an excellent way to torch a phone or an electric car.

Researchers from China's Huazhong University of Science and Technology (HUST) and Institute of Physics have now created a puncture-resistant solid-state battery. Their battery, as reported in *Nature Communications* (https://www.nature.com/articles/s41467-023-35857-x), can also operate at a wide range of temperatures: as cold as −50°C and as high as 70°C.




This solid-state Li battery tolerates puncture, even when it is fully charged. Image credit: Xin Guo.

To create such a versatile battery, the researchers needed to overcome the fact that suboptimal temperatures cause $Li^+$ ions to move slowly through the battery's electrolytes and unevenly deposit. But by prudently fluorinating their polymer electrolytes, the researchers created express pathways to carry $Li^+$ at high speeds and ensure an even deposition.

When the researchers subjected their battery to puncture tests at the tip of a needle, the battery stayed inert and continued to function normally afterward.

Several factors are credited for the battery's puncture resistance. For one, the electrolytes are nonflammable. For another, the electrolytes are thermally stable up to 350°C and even at higher temperatures, they do not leak reducing gases such as methane or ethylene. Additionally, the electrolytes are electrochemically stable up to 5.2 V, preventing reactions with either electrode.

"No combustible matter is released from our polymer electrolytes during the puncture test," says Xin Guo of HUST.

Pedro Guerrero, a materials scientist at the University of the Basque Country, who was not involved in this work, says that solid-state ceramic or polymer electrolytes may be safer than batteries with liquid electrolytes. "However, the solid electrolytes in solid-state batteries are generally more brittle and less flexible than their liquid counterparts," he says. They can also have other drawbacks, such as poor ionic conductivity at room temperature and an interfacial layer that forms on the electrode surface. Solid-state electrolytes can also be unsustainable.

Guo, for his part, believes their batteries' resistance to damage could make many applications safer, preventing sudden fires. "Because of the high safety, our batteries are especially suited to electric vehicles and energy storage," Guo says. Moreover, he hopes that their ability to operate in a wide temperature range will simplify the thermal management system these batteries need, allowing them to carry higher energy densities at lower cost.

**Rahul Rao**