PUBLISHED: 8 AUGUST 2017 | VOLUME: 2 | ARTICLE NUMBER: 17139

research highlights

ELECTROCHEMICAL STORAGE

Liquefied gas solvents

Science **356,** eaal4263 (2017)

Electrolytes based on liquid solvents are widely adopted in electrochemical energy storage systems such as lithium-ion batteries and capacitors. Consumer applications such as electric vehicles require storage devices capable of stable performance in very cold climates (for example, as low as –60 °C). However, storage systems based on liquid electrolytes generally do not work well at low temperature because reaction kinetics are slowed down. Independently, the ever-growing need for higher energy density also requires radical changes of design in storage devices. Shirley Meng and colleagues from the University of California, San Diego, USA, have now reported electrolytes composed of liquefied-gas solvents for low-temperature operation, with much-improved energy density and efficiency compared to conventional storage devices.

The researchers consider a range of hydrofluorocarbon solvents that are gaseous at room temperature and atmospheric pressure but that liquefy under moderate pressure. These solvents have low viscosities and freezing points, which enable high ionic conductivity and device operation at low temperatures. The researchers demonstrate the use of a fluoromethane-based liquefied-gas electrolyte in a lithium–metal battery. A high capacity retention of 60.6% at –60 °C is reported with respect to the room-temperature capacity. In contrast, conventional liquid electrolytes freeze at such a low temperature. A key indicator for cycling efficacy, the coulombic efficiency, remains at a high 97% over 400 cycles. In contrast, lithium dendrites frequently form in conventional liquid electrolytes, a well-known problem that leads to poor cycling stability. In addition to the battery, the researchers also demonstrate a capacitor that uses a difluoromethane-based liquefied-gas electrolyte, which enables a wider range of operation temperature (–78 °C to +65 °C) as well as increased operation voltage, leading to higher energy density compared to conventional capacitors based on liquid solvents.

Changjun Zhang