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Ultra-low Temperature Rechargeable Batteries with MXene Anodes

MXene-based lithium batteries that retain capacity down to –60 °C, enabling reliable energy storage for defense and extreme-cold applications.

The advancement of energy storage technologies is crucial for electrification and decarbonization. Since their commercial debut in 1991, lithium-ion batteries (LIBs) have become the backbone of modern energy storage across multiple industries. However, LIBs face significant challenges, particularly in cold environments in which performance can decline due to increased charge-transfer resistance, electrolyte solidification, and sluggish diffusion of lithium ions within the electrode, leading to incomplete intercalation and enhanced dendrite formation. Traditionally, external heating systems are used to prevent these conditions from developing, which adds weight and decreases energy efficiency.

Researchers at Purdue University have developed an ultra-low temperature rechargeable battery from MXene materials, specifically Ti3C2Tx, as an alternative to conventional graphite anodes to enhance LIB performance in low-temperature environments. Unlike traditional anode materials relying on solid-state ion diffusion, MXenes improve lithium-ion storage kinetics through surface-confined redox activity, thereby addressing the limitations of LIBs under low temperatures.

Technology Validation:

Preliminary results in coin cells indicate that MXene anodes, when paired with dipropyl ether (DPE) electrolyte, retain a significant portion of their capacity even at temperatures as low as -60Â°C, outperforming graphite anodes under similar conditions.

Advantages:

-Enhanced electrical conductivity

-Enhanced ion transport and surface redox reactions compared to graphitic materials, leading to capacity retention at low temperatures and fast kinetics

Technology ID

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Category

Aerospace & Defense/Defense Electronics & Surveillance Technologies

Energy & Power Systems/Energy Storage

Further information

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Applications:

-Low temperature applications

-Rechargeable batteries

-National defense

TRL: 4

Intellectual Property:

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