A research group at Japan's Tohoku University has developed a prototype calcium metal rechargeable battery capable of 500 cycles of repeated charge-discharge – the benchmark for practical use.

In a paper published in the journal Advanced Science, the scientists explain that as the fifth most abundant element on earth's crust, calcium is widely available and inexpensive, and has the potential of providing higher energy density than the present components of **lithium-ion batteries** (LIBs). Its properties are also thought to help accelerate ion transport and diffusion in electrolytes and cathode materials, giving it an edge over other LIB alternatives such as magnesium and zinc.

However, according to the Tohoku team, many hurdles remain in the way of Ca metal batteries' commercial viability. The lack of an efficient electrolyte and the absence of cathode materials with sufficient Ca2+ storage capabilities have proved to be the main stumbling blocks.

In 2021, some members of the current research group provided a solution to the problem when they realized a new fluorine-free calcium electrolyte based on a hydrogen (monocarborane) cluster. The electrolyte demonstrated improved electrochemical performances such as high conductivity and high electrochemical stabilities.

"For our current research, we tested the long-term operation of a **Ca metal battery** with a copper sulphide (CuS) nanoparticle/carbon composite cathode and a hydride-based electrolyte," Kazuaki Kisu, co-author of the paper, said in a media statement.

Kisu explained that also a natural mineral, CuS has favourable electrochemical properties. Its layered structure enables it to store a variety of cations, including lithium, sodium and magnesium. It has a large theoretical capacity of 560 mAh g-1 – two to three times higher than present cathode materials for lithium-ion batteries.

Through nanoparticulation and compositing with carbon materials, he and his colleagues were able to create a cathode capable of storing large amounts of calcium ions. When employed with the hydride-type electrolyte, they produce a battery with highly stable cycling performance. **The prototype battery maintained 92% capacity retention over 500 cycles based on the capacity of the 10th cycle.**

Based on these results, the group is confident that their breakthrough will help advance research into cathode materials for Ca-based batteries.

"Our study confirms the feasibility of Ca metal anodes for long-term operations, and we are hopeful the results will expedite the development of Ca metal batteries," Kisu said.

Source: Mining