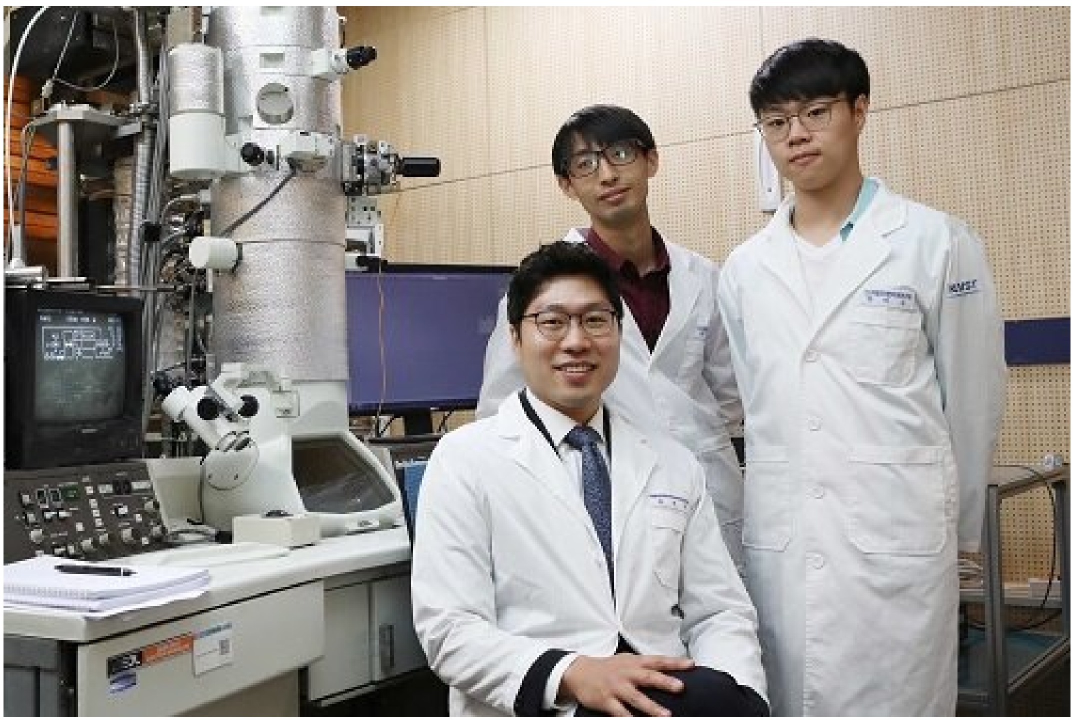
High-performance sodium ion batteries using copper sulfide

July 15 2019



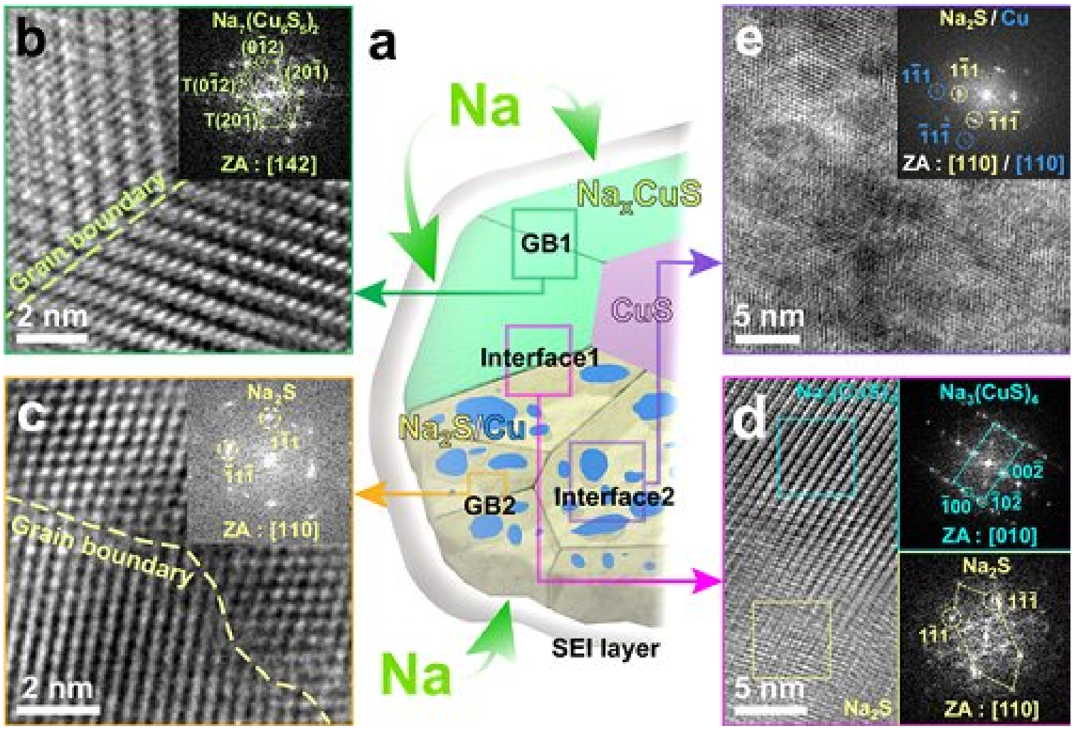
Prof.Yuk and his two PhD candidates Parks. Credit: KAIST

Researchers presented a new strategy for extending sodium ion batteries' cyclability using copper sulfide as the electrode material. This strategy has led to high-performance conversion reactions and is expected to advance the commercialization of sodium ion batteries as they emerge as an alternative to lithium ion batteries.

Professor Jong Min Yuk's team confirmed the stable sodium storage mechanism using copper sulfide, a superior electrode material that is pulverization-tolerant and induces capacity recovery. Their findings suggest that when employing copper sulfide, sodium ion batteries will have a lifetime of more than five years with one charge per day. Even better, copper sulfide, composed of abundant natural materials such as copper and sulfur, has better cost competitiveness than lithium ion batteries, which use lithium and cobalt.

Intercalation-type materials such as graphite, which serve as commercialized anode materials in lithium ion batteries, have not been viable for high-capacity sodium storage due to their insufficient interlayer spacing. Thus, conversion and alloying reaction type materials have been explored to meet higher capacity in the anode part. However, those materials generally bring up large volume expansions and abrupt crystallographic changes, which lead to severe capacity degradation.

The team confirmed that semi-coherent phase interfaces and grain boundaries in conversion reactions played key roles in enabling pulverization-tolerant conversion reactions and capacity recovery, respectively.



Schematic model demonstrating grain boundaries and phase interfaces formations. Credit: KAIST

Most conversion and alloying reaction type battery materials usually experience severe capacity degradations due to having completely different crystal structures and large volume expansion before and after the reactions. However, copper sulfides underwent a gradual crystallographic change to make the semi-coherent interfaces, which eventually prevented pulverization of particles. Based on this unique mechanism, the team confirmed that copper sulfide exhibits a high capacity and high cycling stability regardless of its size and morphology.

Professor Yuk said, "Sodium ion batteries employing copper sulfide can advance sodium ion batteries, which could contribute to the development of low-cost energy storage systems and address the micro-dust issue"

More information: Jae Yeol Park et al, Pulverization-Tolerance and Capacity Recovery of Copper Sulfide for High-Performance Sodium Storage, *Advanced Science* (2019). DOI: 10.1002/advs.201900264

Provided by The Korea Advanced Institute of Science and Technology (KAIST)